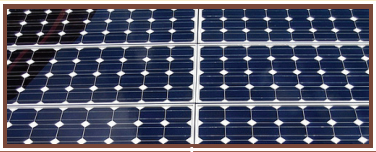
Comprehensive Energy and Water Master Plan

Redstone Arsenal


2009


U.S. ARMY

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2009		**00-00-2009 to 00-00-2009**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Comprehensive Energy and Water Master Plan, Redstone Arsenal	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Department of the Army,Redston Arsenal,AL**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

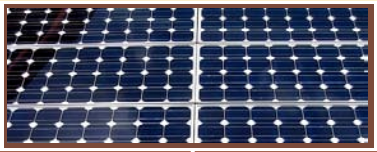
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**92**	

Comprehensive Energy and Water Master Plan

Redstone Arsenal

95% Prefinal Submittal
30 October 2009
United States Army Corps of Engineers Contract No:
W912DY-06-D-0006-0014

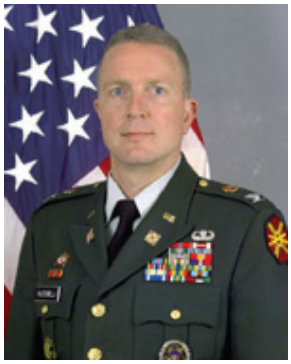
Prepared by:
Rexroad APG, LPA


2009


U.S. ARMY

DEPARTMENT OF THE ARMY
UNITED STATES ARMY GARRISON
REDSTONE ARSENAL, ALABAMA



Letter from the Commander

Redstone Arsenal plays a significant role in the defense of the United States. Its primary mission is to perform basic and advanced weapons system research and development, placing the right missile and aviation systems with the troops, keeping them ready to fight, providing weapon systems, services and supplies to our allies, to manage weapon systems such as the Cobra and Patriot, and to support project managers within the program executive office structure.

This Comprehensive Energy and Water Master Plan is an essential guide for managing infrastructure master planning, providing strategies for energy and water efficiency, creating alternative energy solutions and providing energy and water security. It incorporates holistic and sustainable planning principles while promoting environmental stewardship throughout our installation. This document is an invaluable resource for those of us tasked with maintaining our infrastructure and reducing the impact of energy and water consumption.

Redstone Arsenal is fully committed to this Plan and its ideology. It is vital to the future of Redstone Arsenal that this document be maintained and utilized as we strive to achieve our vision, goals and objectives while seeking the support of decision makers in the command chain. Redstone Arsenal is committed to utilizing this Plan as a management tool when making decisions that impact the future of the installation and its energy and water systems.

Robert M. Pastorelli
Colonel, U.S. Army
Redstone Arsenal Garrison Commander
October 2009

Executive Summary

ES 1 Purpose, Scope, Authorization and Applicability

Purpose

The purpose of a Comprehensive Energy and Water Master Plan (CEWMP) is to evaluate the current energy and water uses of an installation, make recommendations to improve the current conditions and implement a plan to enact these recommendations. The CEWMP is directed by Installation Management Command (IMCOM) and designed to assist installations in satisfying the following:

- Energy Policy Act (EPAct) of 2005
- Executive Order (EO) 13423
- Energy Independence and Security Act (EISA) of 2007

It also intends to address the recommendations provided by the following:

- Army Energy and Water Campaign Plan (AEWCP) 2007
- American National Standards Institute 2000/Management System for Energy 2005 (ANSI/MSE 2000:2005)

The CEWMP serves as a roadmap for how Redstone Arsenal (RSA) will meet and exceed the various provisions and mandates listed above.

Scope

The CEWMP is a Garrison-level evaluation of all aspects of energy and water management. This evaluation is reflective of the trends and profiles of energy and water usage. The objective of the CEWMP is to provide a strategic level assessment defining current energy and water profiles, reduction and modernization goals, and strategic plans necessary to meet those goals.

Authorization

The development of this document is under United States Army Corps of Engineers (USACE) contract number W912DY-06-D-0006, task order number 0014. The contract is administered by the United States Army Engineering and Support Center, Huntsville (USAESCH); with oversight by IMCOM Headquarters (HQ) and IMCOM Southeast Region.

Application

The CEWMP is applicable to all aspects of energy and water management. The CEWMP is Garrison, installation and tenant specific.

ES 2 CEWMP Process and Vision

Process

The process of the CEWMP is guided by the methodology, visioning workshops, data collection, and personal interviews. The methodology, included as an appendix electronically on CD-ROM, is consistent in the plans for each installation. Visioning workshops are conducted for a detailed analysis of the Strengths, Weaknesses, Opportunities and Threats (SWOT). Resulting from these workshops is an installation specific energy and water vision with corresponding goals and objectives.

Vision

CEWMP VISION STATEMENT
Redstone Arsenal

The Energy and Water Master Plan is a roadmap that envisions secure, reliable, and sustainable energy and water services for Redstone Arsenal. The Plan acts as a framework to achieve at a minimum the mandates outlined in EPAct 2005, EO13423, and EISA 2007 through awareness, measurement, efficiency, and the control of supply and distribution, while establishing stewardship of the environment as a fundamental principle to sound energy and water management.

Redstone Arsenal's long range goal to move toward a self-sustaining future while continuing to support its mission landscape requires a flexible and adaptive plan. This plan must raise environmental awareness for Redstone Arsenal personnel, local communities, and other government agencies. Through the implementation of new technologies, enhanced monitoring and control systems, increased efficiencies, and renewable energy, the plan will achieve new levels of accountability, systems integration, and a path toward elimination of fossil fuel use while maintaining quality of life for Redstone Arsenal personnel.

ES 3 Existing Conditions and Trends

Energy Systems Existing Conditions

Energy sources at RSA include:

- Electric power purchased from the local provider
- Distributed steam purchased from the nearby waste-to-energy plant
- Decentralized steam from several on-post steam production plants
- Natural gas for heat and equipment operation
- Fuel oil for emergency generators and back-up heat
- Propane as a less polluting alternative to fuel oil

The vast majority of energy is supplied and consumed through electricity, natural gas and steam.

The preponderance of RSA's electrical power comes from the Tennessee Valley Authority (TVA). There are three primary substations distributing power to unit substations, which in turn supply facilities. There are some meters in place; however the majority of the individual buildings are unmetered. A project to install 300 meters is currently underway, and another has been initiated to meter all buildings over 29,000 sq ft and reimbursable customers. This will effectively double the number of new meters with remote communication capability.

RSA purchases most natural gas through the Defense Energy Support Center (DESC) and a third-party broker, Interconn Resources. Huntsville Utilities is paid a transportation tariff on these accounts. Eighty-eight (88) gas meters, located throughout the Garrison, represent a capacity of 631,590 cubic feet per hour (CF/hr). The existing natural gas lines are being replaced due to ineffective cathodic protection, which causes corrosion of the system. Additional gas lines are being installed by TVA Energy services to provide for future boilers in facilities which are currently heated by the steam system.

Steam is purchased from a waste-to-energy plant owned by the Huntsville Solid Waste Disposal Authority (SWDA). In a 2003-2004 study of the steam system, it was noted that approximately 45% of the steam energy

was lost in the distribution system, providing for opportunities to reduce consumption through repair. There are also several steam production plants on-post that serve individual or groups of facilities proximally located to each of the plants. These plants use natural gas or fuel oil and have a total steam capacity of 217,000 pounds per hour (lbs/hr).

Energy Trends

Energy consumption rates, evaluated over several years, result in trends that are graphical representations of the projected path of energy consumption. This provides a visual picture of progress made toward meeting Federal mandates.

As shown in Figure ES-1, RSA must continue energy efficiency efforts to meet the 3% annual energy intensity reduction target in accordance with EO 13423. Due to the fact that "energy" is distributed in several forms on RSA, it is important to evaluate individual component trends and make improvements in every facet of energy usage to maximize energy reductions. Evaluations of the separate energy systems are provided in section 3.1.

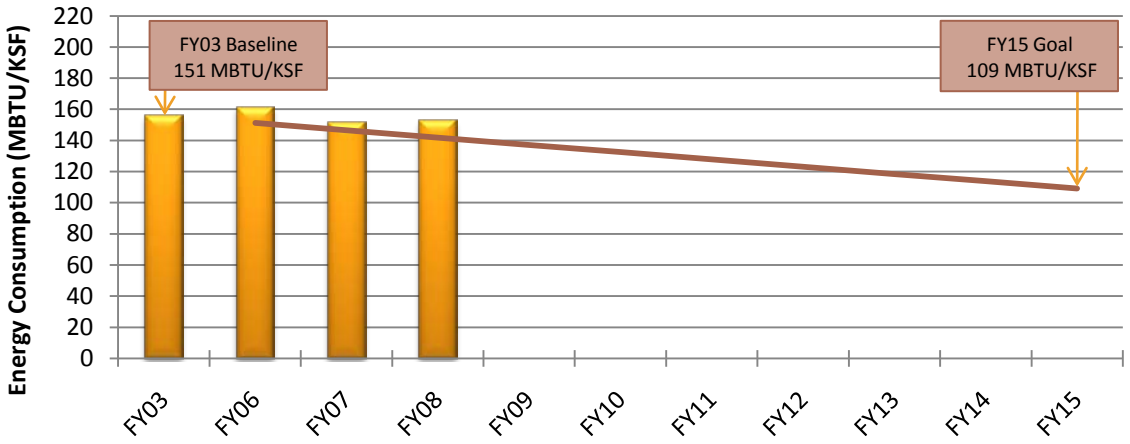


Figure ES-1 RSA Energy Glide Path

Water Systems Existing Conditions

The current primary source for potable water is via four connections to the City of Huntsville's water system. RSA has an integrated industrial water system which meets the needs of the installation and supplies water for one of the two on-site potable water treatment plants (WTP). The potable water system is suspected to have many leaks, as over 40% of the water produced is unaccounted for. Water quality is also an issue because much of the system is comprised of unlined cast iron pipe, which results in a red water residue.

RSA is equipped with a self-contained potable water supply and distribution system which is Government owned and entirely contained within the limits of the installation. The on-site potable WTPs were removed from full-time service in 2006 in an effort to privatize RSA's water supply. They are currently kept on stand-by and occasionally placed into service in order to meet system demands.

The industrial water system represents a significant asset for the day-to-day infrastructure needs of RSA. It currently substitutes 2.4 million gallons per day (MGD) of water that otherwise would be supplied from the potable water system, and represents a viable and potentially cost effective alternative water supply to substitute for other potable water applications.

Water Trends

As shown in Figure ES-2, in FY08 RSA exceeded the EO 13423 water usage intensity reduction target of 16%, based on the FY07 baseline. This target was met in only one year by reducing water usage intensity from 84 gallons per square foot (GAL/ft^2) to 70 GAL/ft^2.

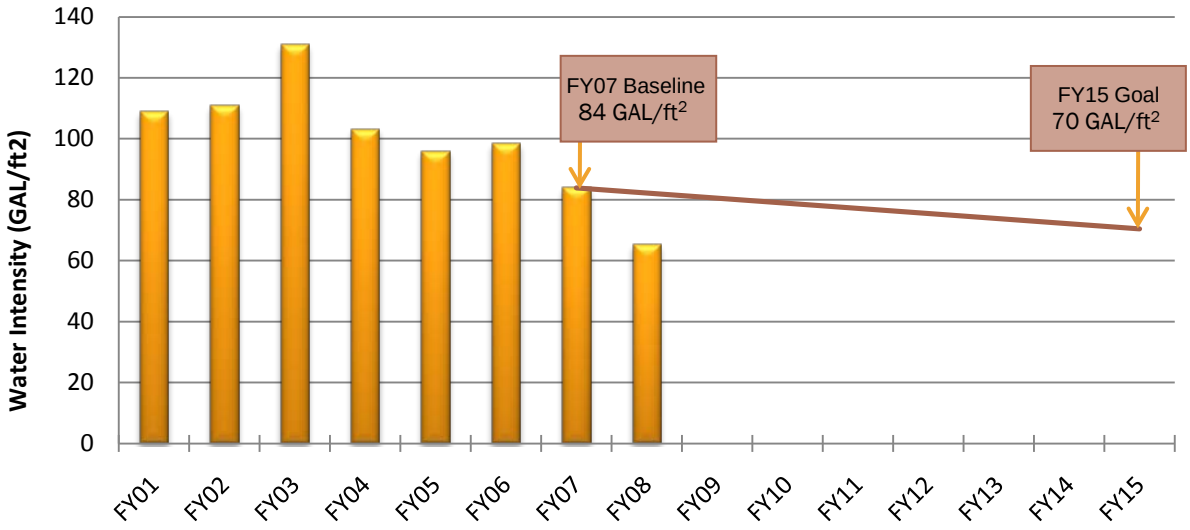


Figure ES-2 RSA Potable Water Glide Path

ES 4 Opportunities and Constraints

RSA has the opportunity to reduce its consumption of fossil fuel derived energy by continuing system efficiency enhancements and altering its focus toward renewable sources. Continued examination and future implementation of renewable resource technology will be crucial to creating a self-sustaining installation. In the short term, RSA can purchase electrical power specifically generated by renewable sources to immediately reduce its carbon footprint and meet federal mandates.

Water system improvements such as the installation of smart meters, a robust leak identification and repair program, and expansion of RSA's industrial water system will further reduce water usage and energy required for potable water processing. Reestablishment of on-site river water as a primary water source will enhance RSA's self sufficiency and ensure adequate water availability.

The main constraint for a self-sustainable future at RSA is a "business-as-usual" culture, which largely ignores specific energy goals. Top level support and communication of conservation methods will be crucial to overcoming this obstacle. Funding constraints will impede progress of efficiency projects; however, an understanding by leadership of the Federal laws and policies regarding energy and water reduction should increase the priority of these projects. A summary of these laws and policies can be reviewed in the Methodology section provided on the attached CD-ROM.

ES 5 Action Plans and Future Focus

The Action Plans and Future Focus items presented in this section provide descriptions of short- and long-term improvements that will reduce energy and water consumption in an effort to meet Federal energy mandates.

Energy Action Plans

- Institute accountability of energy consumption by providing incentives in system maintenance contracts, ensuring LEED-standard design and construction of new facilities, and by establishing tenant responsibility and reporting for utility use.

- Ensure maximum use and benefit of existing control systems through review of system capabilities, facility audits, operator training, and establishment of building control schedules consistent with function.
- Engage RSA personnel in energy conservation through promotional awareness programs by applying professional marketing schemes, establishing energy usage baselines, and instituting reduction incentives and overuse penalties.
- Institute post-wide energy measurement capability with centralized monitoring and analysis through a comprehensive metering program that will collect and analyze energy usage data. This data can be automatically compiled to chart progress toward energy goals as well as identify problem areas.
- Increase renewable energy supply by investigating the use of renewable fuels in conventional plants, reviewing renewable resource studies (especially biomass) accomplished in the region, and maximizing use of the waste-to-energy plant.

Energy Future Focus

The following list provides plans to consider implementing long-range:

- Update CEWMP periodically to check progress toward goals and Federal mandates. This will also allow RSA to establish new goals and analyze technological advancements.
- Procure on-site, non-fossil energy by working with private consultants and energy businesses to study and develop new renewable or nuclear power generating facilities.
- Enhance energy security and self sufficiency by meeting Federal energy targets, converting waste-to-energy steam to electricity, and procuring on-site, non-fossil technologies as it becomes obtainable.

Water Action Plans

The following list provides plans that should be implemented in the short-range:

- Re-establish on-site river water as primary water supply while maintaining connection to Huntsville system as a backup supply only. This will make the RSA water system self-sufficient and take advantage of existing infrastructure.
- Establish system-wide metering of consumption points by establishing an engineered metering plan and installing the required meters.
- Institute awareness and accountability of water consumption through a culture change catalyzed by a marketing scheme and user accountability.
- Maximize use of industrial water for non-potable applications to reduce overall potable water consumption. Golf course irrigation and wash racks are both key areas to convert to industrial water.
- Expand leak detection, repair and replacement program to limit system leaks.
- Perform audits of high water using processes to discover inefficient water usage and implement projects to fix them.

Water Future Focus

The following list provides plans to consider implementing long-range:

- Update CEWMP periodically to check progress toward water reduction goals and mandates.
- Implement comprehensive data management and optimizing tool to track and analyze water usage. This tool would be able to track water use, work order information, and other data to alert operating staff of inefficiencies and possible leaks.
- Integrate a business model that involves integrating efficiencies into equipment procurement practices, increasing preventative maintenance, streamlining operating and maintenance opportunities, and possibly even developing off-site water sales capability.

ES 6 Project Prioritization List

Energy Prioritization

1. Increase staffing for energy management
2. Institute accountability of energy consumption
3. Ensure maximum use and benefit of existing facility control systems
4. Engage RSA personnel in energy conservation through promotional awareness programs
5. Institute post-wide energy measurement and centralize monitoring and analysis
6. Reduce fossil energy consumption
7. Increase renewable energy
8. Periodic CEWMP updates
9. Eliminate fossil energy and achieve self-sufficiency
10. Energy security and self-sufficiency

Water Prioritization

1. Reestablish on-site river water as primary water supply
2. Establish system-wide metering of consumption points
3. Institute awareness and accountability of water consumption
4. Maximize use of industrial water for non-potable applications
5. Expand water main leak detection, repair and replacement program
6. Audits of high water using processes
7. Periodic CEWMP updates
8. Comprehensive data management and optimizing tool
9. Business model integration

ES 7 Appendices and Background Data

The following data is included in the supplemental CD-ROM:

- Appendices. “Appendices” folder
- ASIP. “RSA ASIP.pdf”
- Boiler Inventory. “Boiler Inventory - Redstone 09-21-04.xls”
- Energy Management Plan 2005. “2005 Energy Management Plan.pdf”
- FEDS Groups. “FEDS groups.xls”
- Installation Manpower Status Report (30 Sep 08). “FINAL4QTR08-IMSRr.xlsx”
- Meeting Minutes. “Minutes” folder
- Metering Data. “Metering Data” folder
- Pacific Northwest National Laboratory Audit. “PNNL Audits.xls”
- Project Prioritization System (PPS). “IMA PPS Redstone as of 1-22-09.xlsx”
- Real Property Inventory. “REDSTONE_RealProp_Report_080911.xlsx”
- Redstone Arsenal Metering Project. “Redstone Arsenal Metering Project Combined with RPI & Previous Meter Readings.xlsx”
- Redstone Arsenal Metering Schedule. “Redstone Arsenal Metering Project Schedule 06-05-09.pdf”
- Solar Data. “Solar-Data-Huntsville.pdf”
- Utility Privatization (J2).” J2potable.doc”
- Water Averages 2004. “wateravg.xls”
- Water Management Plan 2004. “Water management plan September 2004.pdf”

Table of Contents

Appendices (Located in attached CD-ROM)

Tables

Figures

This Page Intentionally Left Blank

Section 1

Introduction

1 Introduction

The Comprehensive Energy and Water Master Plan (CEWMP) portrays sustainable methods to reduce energy and water consumption. It establishes a long-range vision for the installation, the goals upon which that vision is based, and the direction needed to attain them.

1.1 Purpose and Background

The CEWMP is directed by U.S. Army Installation Management Command (IMCOM) and is designed to assist installations in satisfying the following:

- Energy Policy Act (EPAct) of 2005
- Executive Order (EO) 13423
- Energy Independence and Security Act (EISA) of 2007

It also intends to address the recommendations provided by the following:

- Army Energy and Water Campaign Plan (AEWCP) 2007
- American National Standards Institute 2000/Management System for Energy 2005 (ANSI/MSE 2000:2005)

The CEWMP serves as a roadmap for how Redstone Arsenal (RSA) will meet and exceed the various provisions and mandates listed above.

1.2 Scope

The CEWMP is a Garrison level evaluation of all aspects of energy and water management. This evaluation is reflective of the trends and profiles of energy and water usage. The objective of the CEWMP is to provide a strategic level assessment defining current energy and water profiles, reduction and modernization goals, and strategic plans necessary to meet those goals.

1.3 Document Usage

The following items generalize the content of each section:

Section One – Introduction

- Gives background and scope
- Presents regional and installation setting
- Provides brief installation history

Section Two – Mission and Vision

- States the Garrison mission
- States the energy and water vision
- Conveys goals and objectives to support the vision

Section Three – Energy and Water Profiles

- Provides an in-depth analysis of supply and distribution, consumption, planning tools and audits
- Visual representation of current trends
- Provides overall assessment of current system conditions for energy and water systems

Section Four – Opportunities and Constraints

- Identifies conservation strategies
- Lists available fuel sources and generation options
- Examines Army energy security goals

Section Five – Action Plans and Future Focus

- Details immediate action plans
- Specifies future focus plans

Section Six – Project Prioritization List

- Functional project checklists
- Specifies project priorities

1.4 Setting

1.4.1 Regional

RSA is located in Madison County which is part of the Tennessee Valley in northern Alabama. RSA is surrounded by the cities of Madison and Huntsville on the north, east, and west sides, and the Tennessee River along the south. The majority of personnel at RSA commute from one of the two surrounding cities.

Population

The population in surrounding areas has been growing continuously, with growth projected to continue in the future. Since RSA purchases energy and water from local utilities, prolonged population growth will put demand related stress on the local areas. Figure 1-2 shows the population growth in the areas surrounding RSA.

Figure 1-1 Installation Location

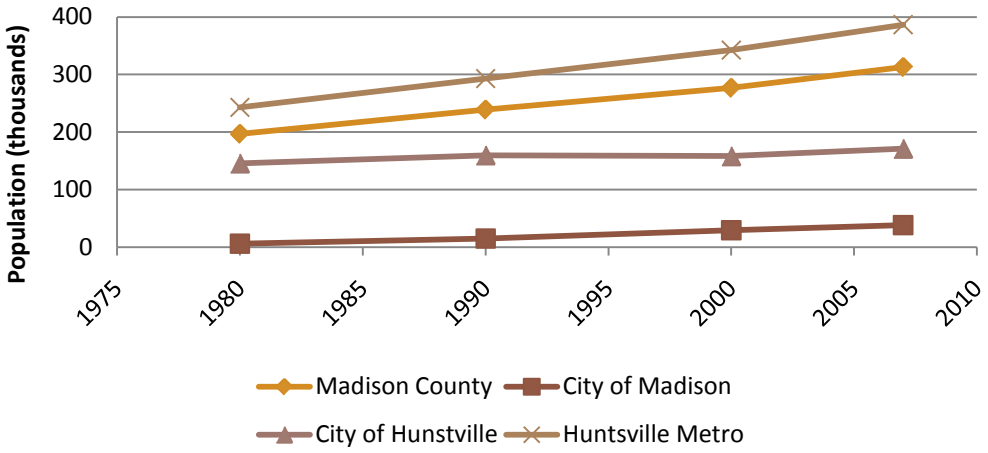
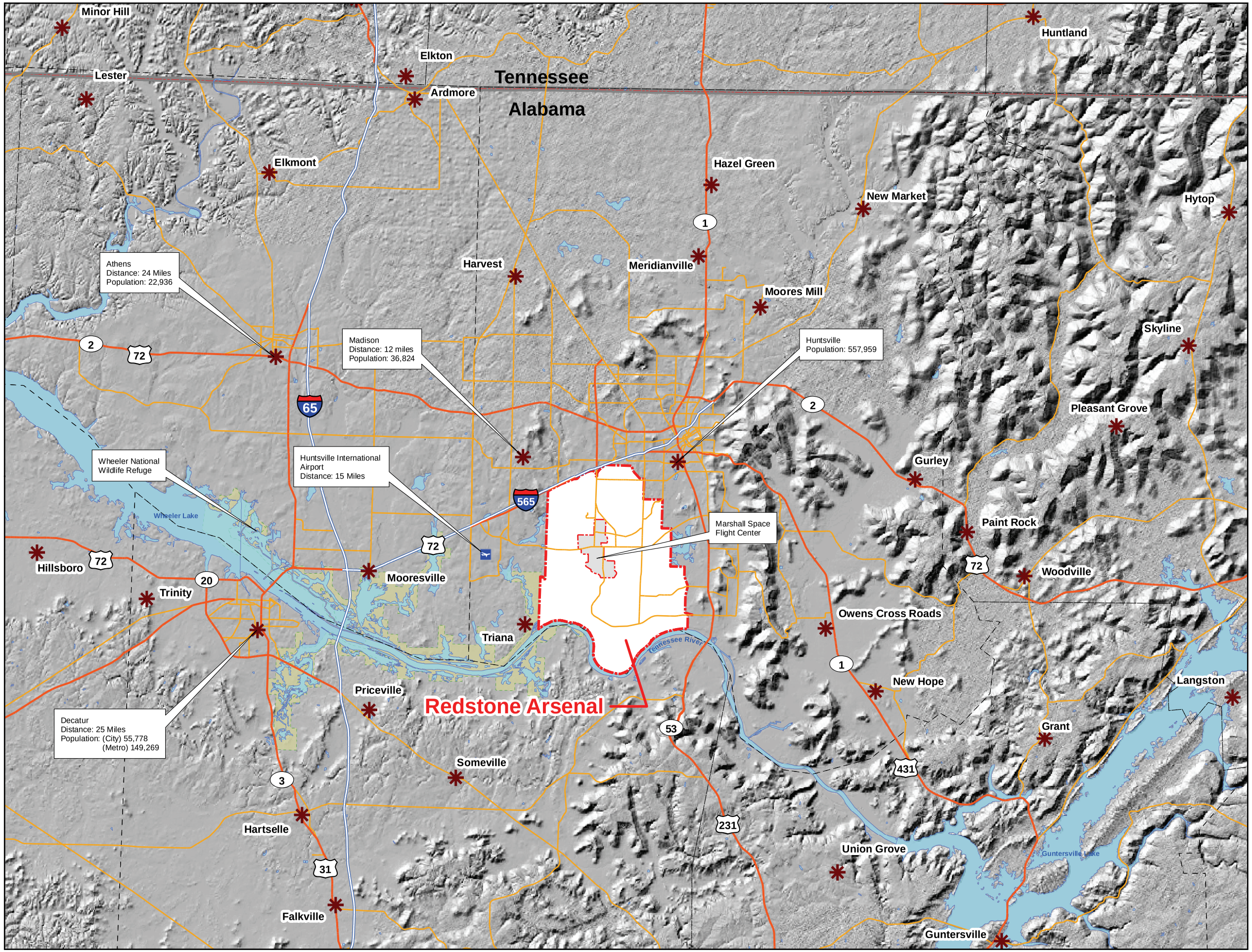


Figure 1-2 Regional Population Growth

Comprehensive Energy and Water Master Plan



Legend

- Airport
- Interstate
- Highway
- Major Road
- Redstone Arsenal
- Marshall Space Flight Center
- City
- County Boundary
- Fish and Wildlife Service
- State Boundary

N
W E
S

0 1.25 2.5 5 7.5 10 Miles

Vicinity Map
Figure 1-3

Version: Prefinal | Date Created: October 2009

Redstone Arsenal
Huntsville, Alabama

Climate

Northern Alabama has a temperate climate. Summers are characterized by warm and humid weather, with frequent thunderstorms. Winters are usually cool, but vary considerably from one year to the next.

Table 1-1 Redstone Arsenal Area Climate Statistics

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
Temperature, Average High (˚F)	48.2	53.5	62.8	72.5	79.3	86.6	89.0	88.8	82.8	73.0	62.4	52.6	71.0
Temperature, Average Low (˚F)	29.2	32.6	40.9	49.0	57.3	64.9	68.9	67.9	61.6	49.3	40.5	33.1	49.6
Heating Degree Days	812	613	417	158	41	0	0	0	13	173	411	685	277
National HDD, 2008[1]	*892*	*741*	*617*	*319*	*183*	*26*	*5*	*7*	*44*	*175*	*521*	*800*	*361*
Cooling Degree Days	0	0	11	32	147	324	434	412	229	56	6	0	138
National CDD, 2008[1]	*10*	*5*	*29*	*23*	*119*	*264*	*310*	*366*	*191*	*82*	*16*	*12*	*119*
Total Rainfall (Inches)	5.17	4.87	6.62	4.93	5.08	4.13	4.85	3.47	4.08	3.25	4.86	5.87	4.77
Snowfall/Freezing Rain (Inches)	1.9	0.8	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.4
Relative Humidity %	72%	68%	65%	63%	69%	70%	74%	74%	74%	70%	71%	72%	70%
Average Sunshine %	42%	50%	54%	63%	66%	65%	59%	63%	61%	66%	55%	46%	58%
Average Wind Speed, mph	9.1	9.5	9.9	9.3	7.9	6.7	6.0	5.8	6.8	7.1	8.2	9.0	7.9
Peak Wind Gust, mph	48	58	70	58	69	67	62	55	48	55	51	53	58
Wind Direction													SE
Wind Category													1*

Source: National Climatic Data Center (2007). NOAA Satellite and Information Service.
* Wind Category 1 generally unsuitable for wind turbine development (U.S. Department of Energy)

1.4.2 Installation

Population

The installation sits on 37,910 acres and includes administrative and laboratory buildings, flight test ranges, and other specialized buildings and equipment. There are 1,769 buildings totaling 11 million gross square feet, most of which is administrative/office space.

The Army Stationing and Installation Plan (ASIP) provides insight into the population breakdown for current year 2009 and projected years out to 2015. The ASIP has been included electronically with this submittal and includes full time and transient military and full time and transient civilian employees. Figure 1-4 provides the projected installation population.

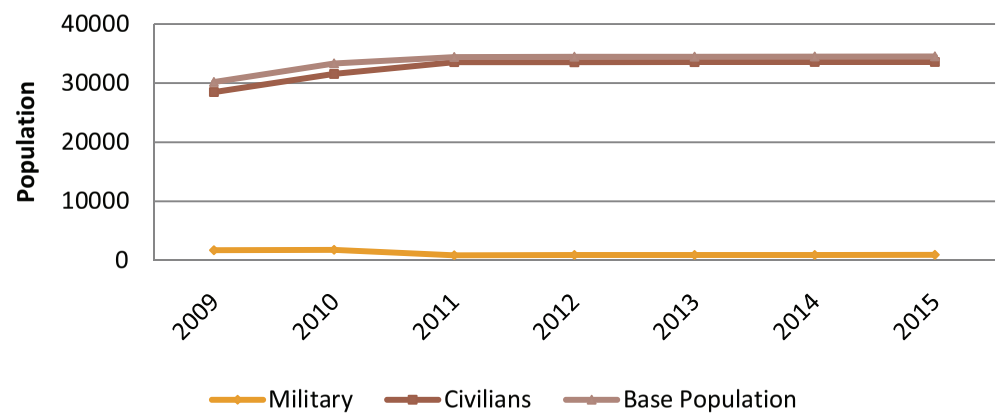


Figure 1-4 ASIP Projected Population Growth

Since the installation projects no major growth, it is reasonable to anticipate that energy and water consumption will remain relatively constant within the installation boundaries.

Installation History

Redstone Arsenal has served for more than 50 years as the Army's center for missile and rocket programs. It was originally built during World War II as three separate installations to support ammunition and chemical warfare materials production. The three installations (Gulf Chemical Warfare Depot, Huntsville Arsenal and Redstone Ordnance Plant) would eventually be consolidated into a single installation now known as Redstone Arsenal.

The Army Ballistic Missile Agency (ABMA) was established in February of 1956. The Army chose RSA as a suitable location to consolidate its newly formed rocket program due to the large areas of open land, empty buildings and abundant access opportunities to transportation infrastructure. The foundation of the ABMA came from the Guided Missile Development Division of RSA's Ordnance Missile Laboratories. During the 1950s, the Army missile team at RSA pioneered many of the United States' accomplishments in space exploration.

On October 21, 1959, President Eisenhower ordered components of the military's space program to be transferred to NASA. In July of 1960 a substantial amount of ABMA facilities was leased to NASA to become the George C. Marshall Space Flight Center. RSA lost all space-related missions as a result of this transformation. Today, the aviation and missile experts at RSA research, develop, test, repair, and maintain the high technology weapons upon which American soldiers depend.

1942 Redstone Arsenal Ammunition Production Line

This Page Intentionally Left Blank

FACILITY	BLDG	SPOT	GRID	FACILITY	BLDG	SPOT	GRID
Airline Ticket Office	4488	1	D-4	Military Personnel Center	3493/3494	12	B-5
AMCOM Acquisition Center	5303	26	D-5	Milton Frank Stadium			A-6
AMCOM Check-In Spec. Troops	3437	14	B-5	Missile & Space Intelligence Center	4545	38	D-4
AMCOM IMMC	5301, 5302,	30	D-5	Motor Pool Area			C-5
	5308, 5309			MP Station	3453	15	B-5
Army Garrison Redstone	4488	1	D-4	NASA Recreation Area			D-3
Assembly Building	4705		C-4	National Guard Patriot			B-6
BOQ	131-136		A-4	OMEMS HQ	3300	10	B-5
Botanical Garden			A-5	Outdoor Recreation Center	5129	31	D-5
Bowling Center	3707	18	B-5	Pagana Gymnasium	3474	11	B-5
Burger King	3231	8	A-5	PEO Aviation	5681	35	D-5
Central Receiving	8022		F-4	PEO Tactical Missiles	5250		D-5
Chapel (Bicentennial)	376	3	A-5	Photo Lab	4489	34	D-4
Child Development Center	3145	4	A-5	Post Exchange	3220		B-5
Civilian Personnel Advisory Center	5308	27	D-5	Post Office	3648		C-5
Civilian Personnel Operations Center	5304	28	D-5	RD&E Center	5400		D-5
Civilians' and Officers' Club	130		A-4	Recreation Area 1			G-5
Class 6/Convenience Store	3234	6	A-5	Recreation Area 2			F-4
Commissary	3224		B-5	Recreation Center	3711	17	B-5
Computation Center/				Redstone Army Airfield			B-3
Defense Megacenter-Huntsville	5201	32	D-5	Redstone Federal Credit Union	3227/4200	9	C-4
Cycling & Conditioning Building	7863		F-5	Regions Bank	3226	7	A-5
DFAS	3206		B-5	Reserve Navy Construction Battalion			A-5
Dining Facility	3443	13	B-5	Rifle/Pistol Range			B-5
DRMO	7408		F-6	Rocket Auditorium	7120	36	E-6
Firehouse Pub	114	37	A-4	Rustic Lodge	8998		G-5
Fitness Center		23	B-5	Saddle Club			B-3
Flordia Institute of Technology	5304	28	D-5	Schields Range			F-3
Fox Army Health Clinic	4100		B-4	School Age Care Program	3400	21	B-5
Gate 1	5106		C-6	Skeet Range			D-5
Gate 2 (Closed)			E-7	SMDC	5220	39	D-5
Gate 3			F-7	Soldalenstube Restaurant	3512	20	B-5
Gate 4			C-5	Sparkman Center	5300-5309		D-5
Gate 5 (Closed)			B-6	Theater	3712	16	B-5
Gate 7 (Guardhouse)	6200		D-2	Thrift Shop	3209	24	B-5
Gate 8 (Guardhouse)	3196		A-5	TMDE	5435	33	D-5
Gate 9	4120		B-4	Trap Range			C-5
Gate 10 (Guardhouse)	3700		B-5	UAH Aerophysics Propulsion Lab	6230		D-3
Guest House	244		A-5	US Space & Rocket Center			A-5
Housing Office	3207	2	B-5	Van Braun Complex	5220-5221		C-5
Joe Davis Stadium			A-6	Vehicle Registration & Badging	3423	22	B-5
Logistics Support Activity	5307	29	D-5	Veterinary	3543	19	B-5
Mars Skeet Range			C-3	Wellness Center	4460		C-4
Marshall Space Flight Center	4200	25	C-4	Wildlife Viewing Area	8967		G-6
McKinley Range			F-4	Youth Center	3148	5	A-5

Comprehensive Energy and Water Master Plan

Legend

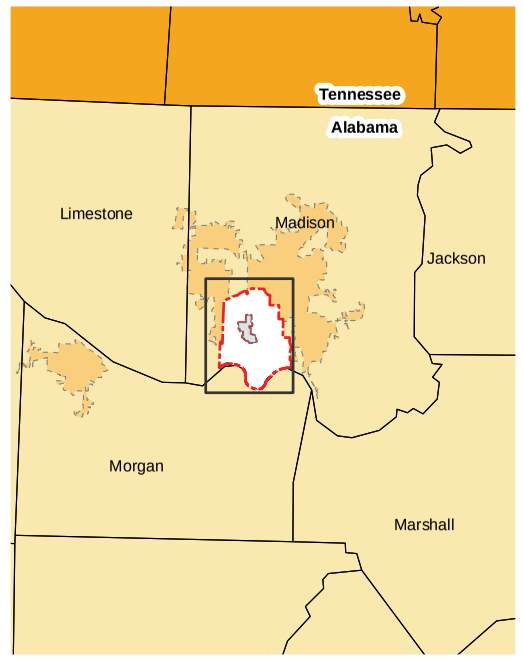
- Gate
- Interstate
- Major Highway
- Surface Water
- Wetland Area
- Fish and Wildlife Service
- Building
- Redstone Arsenal
- Marshall Space Flight Center
- Urban Area

N W E S

0 1,500 3,000 6,000 9,000 12,000 Feet

Installation Key Map
Figure 1-5

Version: Prefinal | Date Created: October 2009



Redstone Arsenal
Huntsville, Alabama

This Page Intentionally Left Blank

Section 2

Mission and Vision

2 Mission & Vision

Redstone Arsenal (RSA) is a bustling installation replete with many military and civilian organizations primarily focused on the development of future weapons systems, equipment and vehicles used by federal agencies. Civilian and contract personnel make up the bulk of the installation population, outnumbering military personnel by more than sixteen to one. The installation currently oversees the research, development, engineering, testing, procurement, production, and logistical support of the Army's aviation, missile, and rocket systems. This mission requires a large supply of energy and water. In order to reduce consumption and move toward sustainability while continuing the high levels of research and development, a vision was created for the future of Redstone Arsenal infrastructure.

RSA Early Rocket Launch

2.1 Mission

The mission of Redstone Arsenal is to "perform basic and advanced weapons system research and development, placing the right missile and aviation systems with the troops, keeping them ready to fight, providing weapon systems, services and supplies to our allies, to manage weapon systems such as the Cobra and Patriot, and to support project managers within the program executive office structure."

2.1.1 Tenants

- Aviation and Missile Research, Development, and Engineering Center
- Civilian Human Resource Agency
- Fox Army Health Center
- Logistics Support Activity
- Ordnance Munitions and Electronics Maintenance School
- Program Executive Office Missiles and Space
- Redstone Technical Test Center
- U.S. Army Aviation and Missile Life Cycle Management Command
- U.S. Army Space and Missile Defense Command/Army Forces Strategic Command
- Federal Bureau of Investigation Hazardous Devices School
- Marshall Space Flight Center
- Missile and Space Intelligence Center
- Program Executive Office Aviation
- Ground-Based Midcourse Defense Joint Project Office

Figure 2-1 RSA Tenant Units

CEWMP VISION STATEMENT
Redstone Arsenal

The Energy and Water Master Plan is a roadmap that envisions secure, reliable, and sustainable energy and water services for Redstone Arsenal. The Plan acts as a framework to achieve at a minimum the mandates outlined in Energy Policy Act (EPAct) of 2005, Executive Order (EO) 13423, and Energy Independent and Security Act (EISA) of 2007 through awareness, measurement, efficiency, and the control of supply and distribution, while establishing stewardship of the environment as a fundamental principle to sound energy and water management.

Redstone Arsenal's long range goal to move toward a self-sustaining future while continuing to support its mission landscape requires a flexible and adaptive plan. This plan must raise environmental awareness for Redstone Arsenal personnel, local communities, and other government agencies. Through the implementation of new technologies, enhanced monitoring and control systems, increased efficiencies, and renewable energy, the plan will achieve new levels of accountability, systems integration, and a path toward elimination of fossil fuel use while maintaining quality of life for Redstone Arsenal personnel.

2.2 Energy and Water Vision

Every Army installation faces a myriad of challenges, not the least of which is the efficiency and security of energy and water systems. This extremely complex issue requires consideration of a broad horizon with input from daily users, system managers and facilitators. The best forum for gathering input, documenting existing conditions and reaching consensus is a visioning workshop. This process allows the installation to come together to communicate core values, identify emerging trends and generate understanding of a preferred future vision.

Table 2-1 Visioning Workshop Participants

Name	Office	Role
Andrew Jantzer	Buchart-Horn	Facilitator
Barb Hough	Rexroad APG	Facilitator
Brad Chadwell	Battelle	Facilitator
Peter Castricone	Rexroad APG	Facilitator
Steve Ricci	Battelle	Facilitator
Walker Secker	Rexroad APG	Facilitator
Les Miller	IMSE-RED-PWB	Energy Group
Mark Smith	IMSE-RED-PWB	Energy Group
Paul Volkman	IMPW-E	Energy Group
John Green	IMSE-RED-PWM	Energy Group
Greg Calvert	IMSE-RED-PWB	Water Group
Jason Scott	IMSE-RED-PWM	Water Group
Jerry Robinson	IMSE-RED-PWB	Water Group
Kevin Burleson	IMSE-RED-PWM	Water Group
Tim Smith	IMSE-RED-PWB	Water Group

A visioning workshop with key stakeholders from Redstone Arsenal was conducted in February of 2009. The workshop participants were divided into three groups: (1) Energy Team, (2) Water Team, and (3) Facilitators. Key stakeholders in attendance at the Redstone Arsenal visioning can be found in Table 2-1.

The Oregon Model for visioning was followed at RSA. This process involves four basic steps which define a comprehensive vision:

- Where are we now?
- Where are we going?
- Where do we want to be?
- How do we get there?

2.2.1 SWOT Analysis

The Strength, Weaknesses, Opportunities, and Threats (SWOT) analysis was used to answer "Where are we now?". The SWOT analysis is defined as follows:

- Strengths: Attributes of the installation that are helpful to energy and water efficiency
- Weaknesses: Attributes of the installation that are harmful to energy and water efficiency
- Opportunities: External conditions that are helpful to achieving energy and water efficiency goals
- Threats: External conditions that could impede progress toward achieving energy and water efficiency goals

The aim of this exercise was to identify the key factors that are important to achieving the greatest levels of efficiency and security for energy and water systems. In order to delineate real potential to move forward and identify concrete factors impeding progress it was critical to take a macro view of the installation and surrounding region.

There were many strengths presented and discussed within the energy group, the greatest of which was the data delivered as a result of a recent Facility Energy Decision System (FEDS) analysis completed by the Pacific Northwest National Laboratory (PNNL). This model presents a clear picture of how energy is consumed at Redstone Arsenal and identifies the most cost effective retrofit measures to improve efficiency.

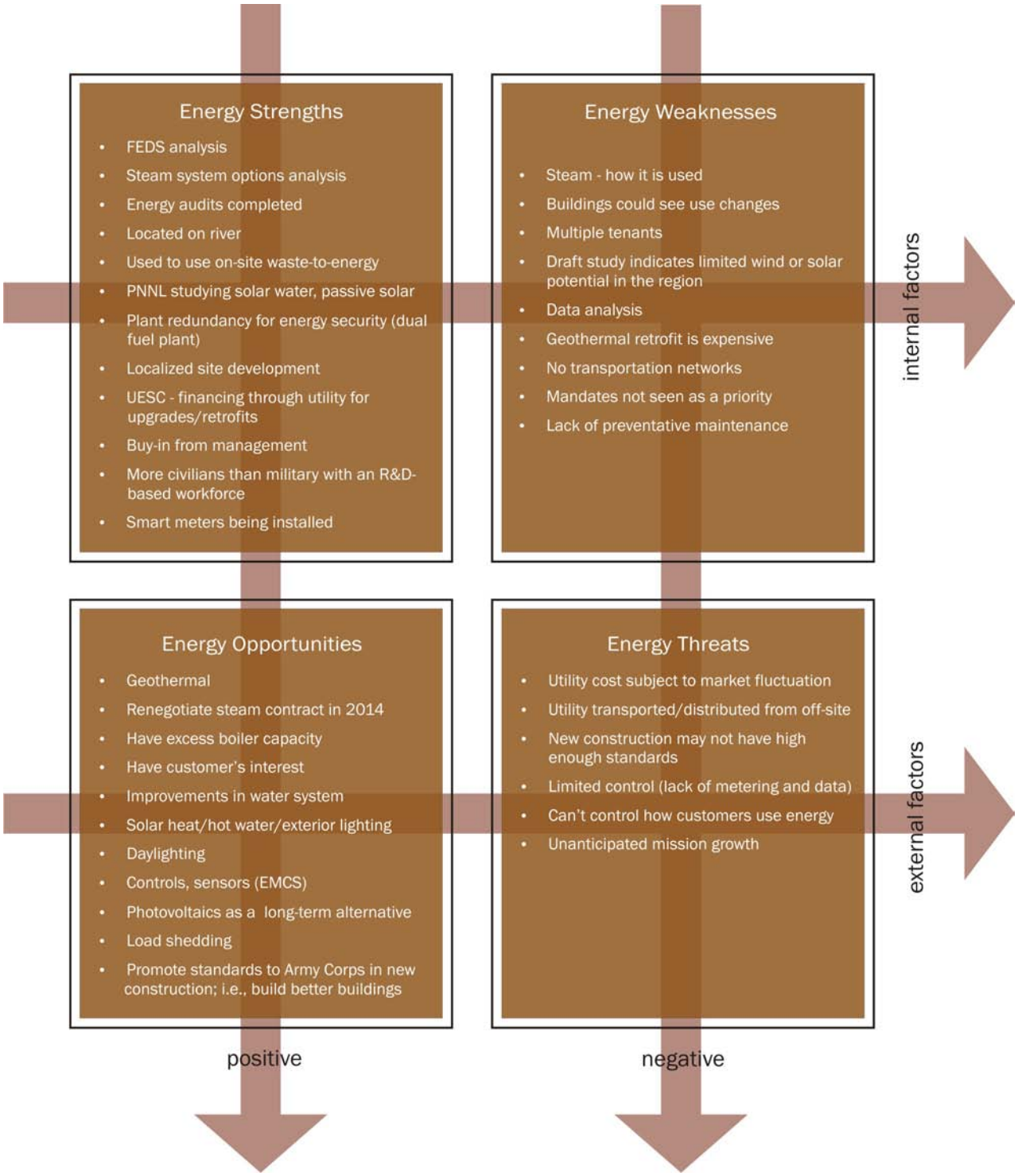
The PNNL is continuing research at this location as they consider opportunities for solar water heating capability. Other strengths discussed include a dual fuel plant, which provides some redundancy and increased security. The aggressive Utility Energy Service Contract (UESC) program was explained in detail and represents a great strength as the installation upgrades infrastructure. Opportunities for alternative and renewable energy sources were addressed. Resulting strengths include the geographic location on the Tennessee River (as a source of future hydroelectric power), the density of the cantonment area, and the high level support for energy initiatives.

Extensive Discussion among the Energy Team

The installation of "smart meters" for a portion of buildings is an obvious strength, but the lack of meters for remaining buildings is considered a weakness. In general, the lack of tools for data analysis was thoroughly covered and added to the chart as a weakness. The inefficiency of the steam system was seen as a weakness, as discussion focused on the 45 percent loss of energy through distribution. The difficulty in managing multiple tenants in an atmosphere where building occupants and their associated missions could dramatically change energy use requirements was reviewed. In addition, a lack of preventive maintenance for both energy and water was discussed and documented as a weakness.

Excess boiler capacity at Redstone Arsenal was considered an opportunity, as was the possibility to enhance awareness and incentive programs. The potential to use Energy Management Control Systems (EMCS) and load shedding technology was addressed as a future opportunity.

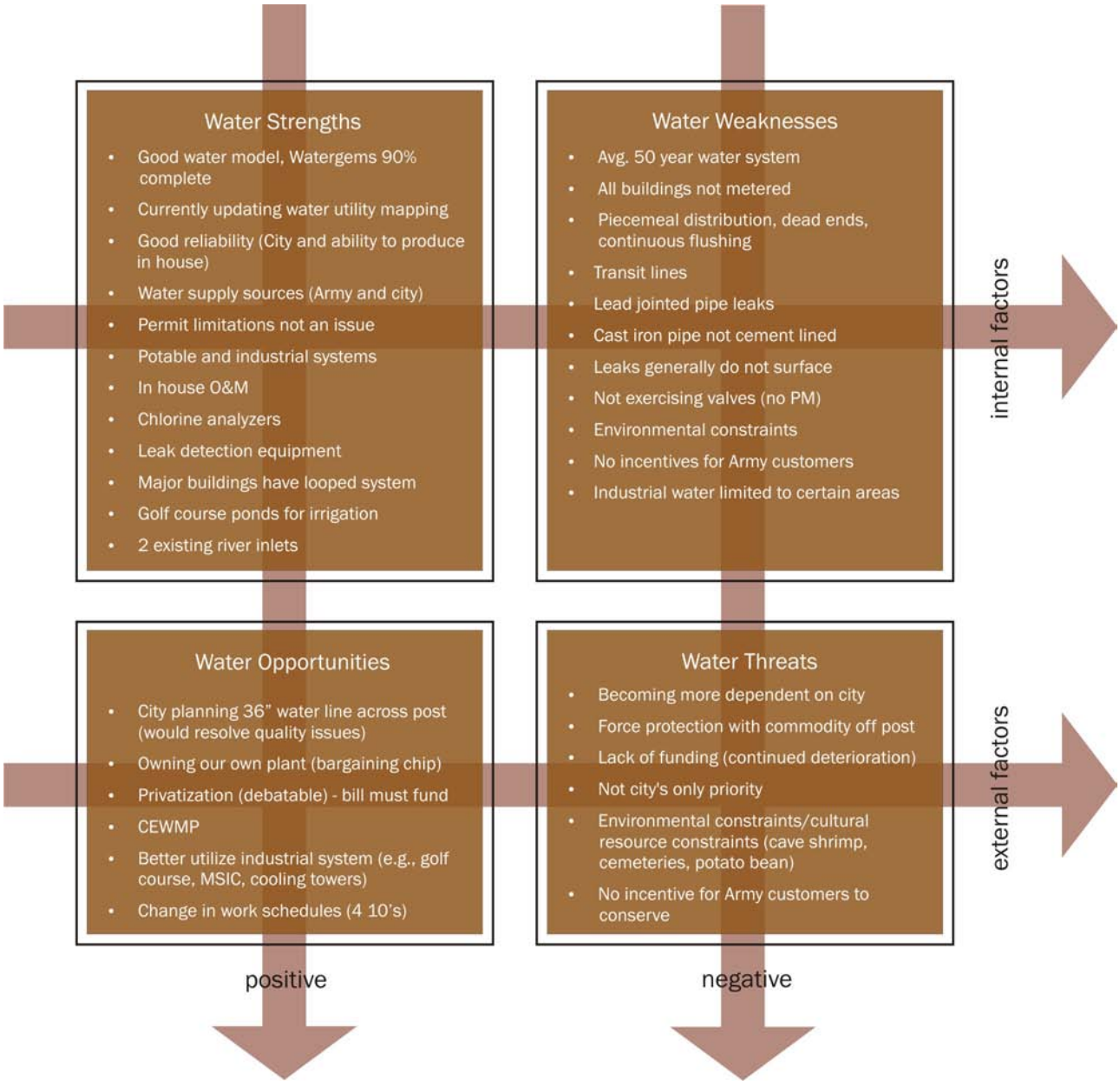
Opportunities were also found in the promise of new technologies, as well as in geothermal and photovoltaic energy sources. In addition, high standards for new construction through the Leadership in Energy & Environmental Design (LEED) program were seen as beneficial to meeting goals for reduced energy consumption.



External factors that are considered threats include market fluctuation for energy costs and reliance on off-site sources. Limited control over tenants and other customers was discussed as a threat, as was the lack of metering and limited data to monitor activities. The uncertainty associated with potential mission growth was also a topic of discussion when reviewing energy threats.

Discussion in the water group focused on the inability to manage what you cannot measure. Lack of meters at the building level was seen as a weakness, as it is critical to create a reliable baseline of data in support of meeting goals for reducing consumption. Meters would also be helpful for identifying problem areas for water loss. It is

known that there are massive amounts of water lost due to system leaks, which never surface. The Water Profile described in Section 3.2 indicates that approximately 42 percent of baseline water production is lost in this manner.



This dialogue led to bullet points for water weaknesses, to include the system age, lead-jointed pipe leaks, and lack of metering. Water strengths were also identified under the same topic of discussion. It was noted that recently acquired leak detection systems have been extremely beneficial in quantifying the problem, and that the current project to update Geographic Information System (GIS) data will be invaluable as Redstone Arsenal works to repair the leaks. A related discussion revealed grave concerns about the age of the water system in general, with bullet points for water weaknesses regarding piecemeal distribution and older materials, such as cast iron and transite. External factors seen as threats included cultural resource constraints at water intake points and a lack of funding to upgrade the aging infrastructure.

The separate infrastructure for industrial and potable water systems was seen as a strength. This was also discussed as an opportunity to reduce potable water consumption systems through the addition of a water main extension, which would provide for irrigation and support the cooling towers. Having multiple sources of water was

seen as a strength, as this increases reliability and security. An external opportunity was found in potential city plans for a new 36 inch water main across the installation, which would resolve water quality issues. There was a great deal of discussion regarding programs in place to lower irrigation requirements at the golf course through retention ponds. This was seen as a great strength.

SWOT Analysis by the Water Group

Overall, the SWOT analysis for water revealed that the age of the infrastructure is a weakness, as is the amount of water unaccounted for through leaks and losses. The inability to develop a solid baseline from which to measure reduced consumption, due to lack of metering, was considered a weakness; however, the plan to add meters is an opportunity. Strengths included multiple water sources, new equipment for leak detection, and updated GIS data.

2.2.2 Trend Analysis

Trend analysis is an essential element to the visioning process. This process reveals where the installation is headed if current trends and activities continue, answering the "Where are we going?" query. This element of the visioning workshop most clearly makes the case for including a variety of participants. It is critical to have the technical and research staff present to discuss industry innovation and success stories. It is equally important to have installation engineering personnel on hand to share historical trends for these systems, which may not be documented at all. The building managers and occupants provide yet another perspective when asked to convey the trends from their points of view.

current energy trends

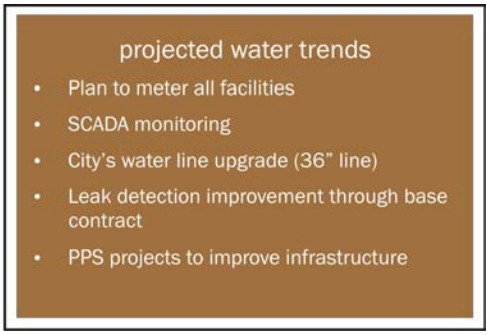
- Improving steam by pruning, maintenance (more efficient use of steam)
- Moving toward better data collection via metering (smart meters)
- Minimizing distribution
- Tuning boilers
- Solar

projected energy trends

- Major efficiency improvements
- Getting buy-in
- Education
- Better stewardship
- Increased energy security through redundancy, resiliency, and securing energy supply
- Better control over industrial buildings (meters/controls)
- Using solar, waste-to-energy for steam, and thermal

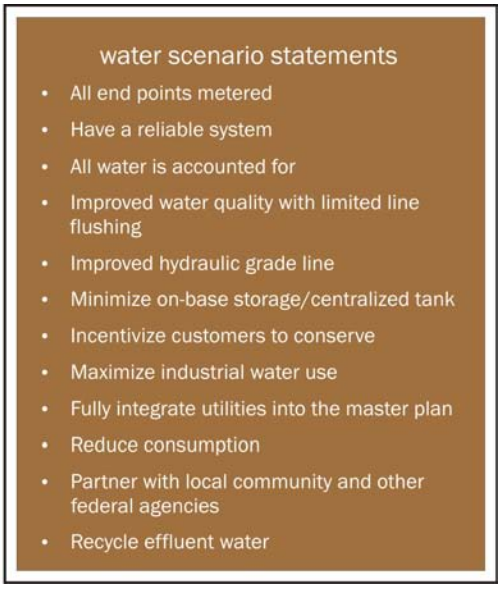
The energy group reflected a trend toward better data collection and monitoring systems for current trends but expounded on future trends for programs to increase awareness and security. The advancement of renewable and alternative fuel sources was also presented as a projected trend for energy.

The water group also facilitated a discussion that focused on metering activities on the installation, as well as plans for repair of system leaks and other upgrades through the Provisioning Performance Schedule (PPS). In general, it was determined that Redstone Arsenal is working toward improving infrastructure, increasing monitoring systems, and incorporating water efficiency standards in all new construction.



2.2.3 Scenario Testing

The process to build the vision begins with the concept of scenario testing to answer the question "Where do we want to be?". Workshop participants were asked to document bullet statements for preferred scenarios related to the energy and water systems at Redstone Arsenal. These scenario statements are the foundation of the vision statement and represent a desired end state.



2.2.4 Implementing the Vision

The following goals and objectives have been incorporated into each Action Item discussed in Section 5 within this document to support attainment of the vision statement. These goals serve as an overall guide to the progress which must be made at RSA to expand sustainability and efficiency. In the future, the progress at RSA can be compared with these goals to measure the level of success and to determine what areas are in need of improvement.

The visioning workshop participants worked as a group to list the objectives that supported the draft vision statement. The Energy Manager at RSA led the group in identifying common themes for objectives and pulled these elements under a common goal. The five common goals are as follows:

Goal: Culture Change

Objectives:

- Getting buy-in
- Create incentive program
- Enhance awareness
  - Various levels
  - Signs and events
  - Multiple audiences
  - Sustained
- Develop internal marketing plan
- Instill accountability

Goal: Provide Comprehensive Data Management and Measurement

Objectives:

- Develop or implement a data collection and analysis plan
- Complete metering
- Establish a continuous metering plan
- Improve energy and water accounting
- Enhance Supervisory Control and Data Acquisition (SCADA) / Geographic Information System (GIS) tools
- Verify spatial data for utilities
- Develop a data management system

Goal: Eliminate Waste and Inefficiencies

Objectives:

- Improve efficiency
- Identify waste, provide leak detection
- Conduct utilization studies
- Increase preventative maintenance
- Re-commissioning and continuous commissioning
- Develop load management program
- Develop audit plan
- Create Capital Investment Strategies (CIS)
- Install Energy Management Control Systems (EMCS)

Goal: Improve Business Management Process and Practices

Objectives:

- Get energy and water awareness into design process
- Educate workforce
- Educate tenants
- Buy Energy Star
- Improve internal work order process
- Improve approval process
- Improve Supply chain / procurement process
- Validate Integrated Facilities System (IFS) data

Goal: Enhance Security

Objectives:

- Multiple supplies to create redundancy
- Plan for realistic self-sustainment
- Add renewable source
- Evaluate alternatives to steam
- Sustain critical facilities
- Upgrade water plant
- Conduct risk analysis

This Page Intentionally Left Blank

Section 3

Energy and Water Profiles

3 Energy and Water Profiles

3.1 Energy Systems

Energy sources at Redstone Arsenal (RSA) include:

- Electric power purchased from the local provider
- Distributed steam purchased from the nearby waste-to-energy plant
- Multiple natural gas boiler plants
- Natural gas for equipment operation
- Fuel oil for emergency generators
- Fuel oil for back-up heat
- Propane as a less polluting alternative to fuel oil

Table 3-1 provides a detailed breakdown of the energy consumption by energy source and total energy consumption. The total area, or square footage, of facilities on RSA increased marginally (1.6%) from 2003 to 2008. Total energy consumption intensity, or consumption per unit area (millions British thermal units per thousand square feet, or MBtu/KSF), has decreased by 2% as of 2008. A closer look at energy consumption by energy source (Table 3-1) reveals that substantial reductions have been achieved in the steam systems and fuel consumption (fuel oil, propane).

Table 3-1 Energy Consumption Intensity Progress 2003-2008 (MBtu/KSF)

	2003	2006	2007	2008	% Change FY03-FY08
Electric	64.45	72.25	69.15	72.40	+12.3%
Natural Gas	26.57	28.45	26.90	31.15	+17.2%
Steam & Hot Water	62.25	57.35	53.71	46.82	-24.8%
Fuels	2.57	3.38	2.26	2.32	-9.6%
Total Energy	155.84	161.43	152.02	152.69	-2.0%

The Energy Glide Path in Figure 3-1 shows the progress that has been made at RSA toward the Federal energy reduction target since its inception. Executive Order 13423 established a 3% annual reduction goal based on fiscal year (FY) 2003 consumption rates, beginning in FY06. This computes to an annual reduction of 4.67 MBtu/KSF.

RSA's total energy reduction has been limited mostly because improvements in steam and fuel consumption have been offset by increases in electricity and natural gas consumption. Another factor that limits progress in energy reduction is that new facilities typically perform at an energy intensity level that is closer to the 2003 baseline than to the 2015 target. This is despite the best efforts by the Energy Manager, master planners, and Army Corps of Engineers to include the requirements of Energy Policy Act (EPAct) of 2005 and Energy Independence and Security Act (EISA) of 2007 in specifications and requests for proposals for new facilities.

The following sections describe the energy supply and distribution systems on the installation and discuss energy consumption trends.

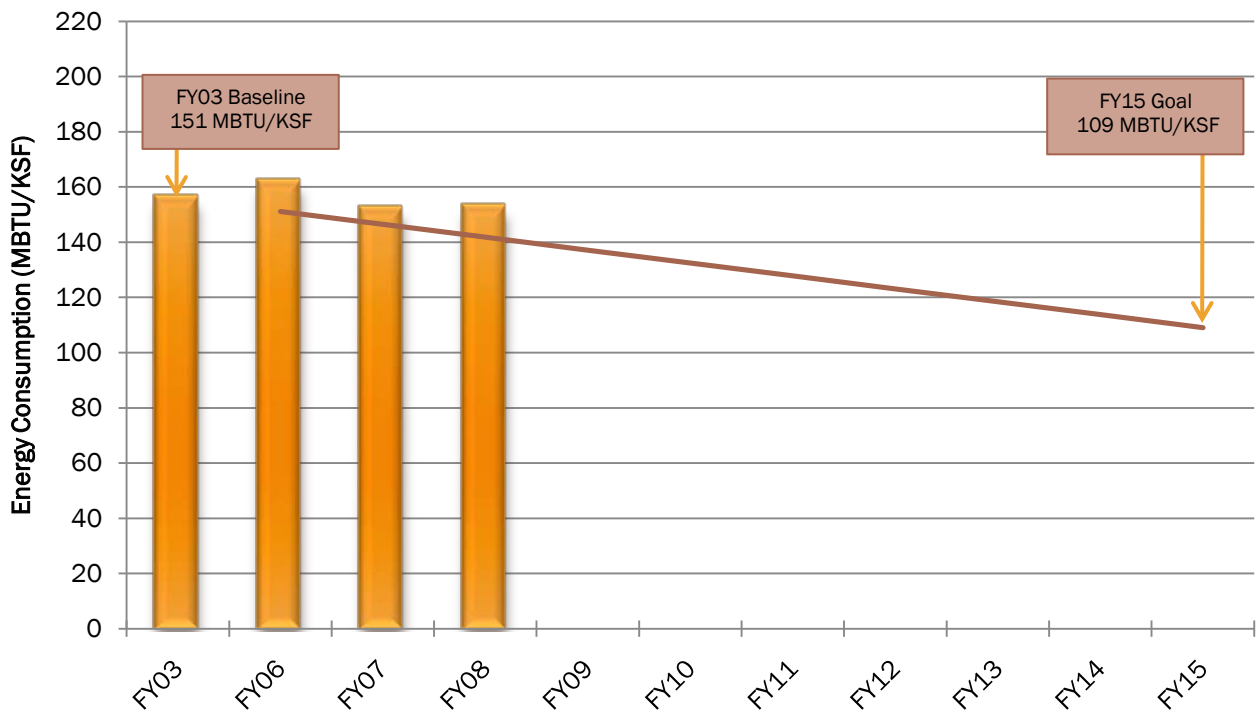


Figure 3-1 Redstone Arsenal Energy Glide Path

3.1.1 Electrical System

3.1.1.1 Supply and Distribution

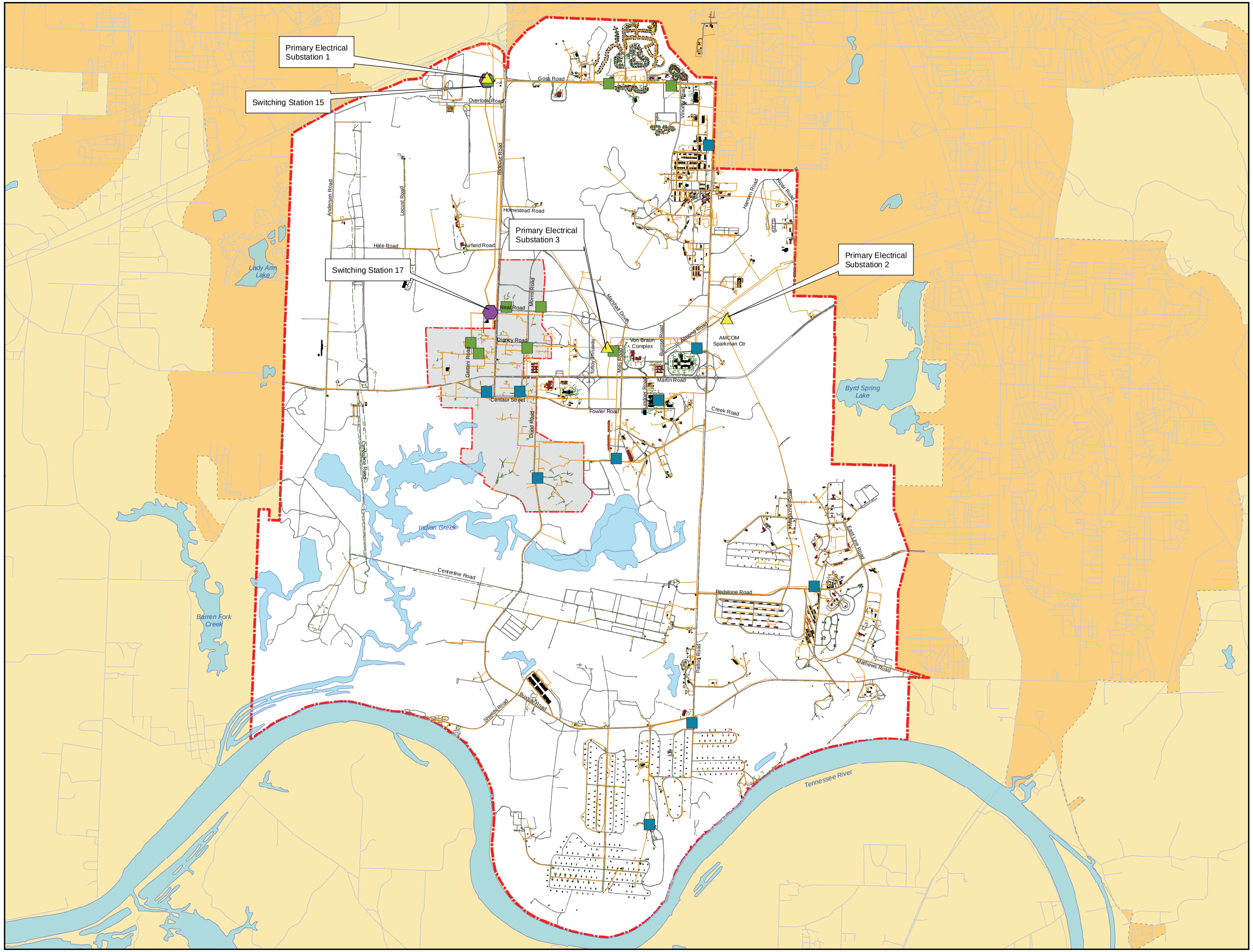
RSA receives most of its primary electrical power from the Tennessee Valley Authority (TVA). Power is received through two primary substations (Primary 1 West and Primary 2 East). Primary 1 is equipped with 9 unit substations and 2 switching stations, while Primary 2 has 10 unit substations. The location of substations is shown in Figure 3-2. Electrical substations are equipped with capacitor banks and there are numerous Uninterruptible Power Supply (UPS) systems ensuring continuous power availability for specific applications.

The Sparkman Center and the Wernher von Braun Complex each have their own electrical production power plants for emergency backup purposes. Both are powered by natural gas and owned and operated by RSA. A third primary substation supports these power plants. These power plants are owned and operated by RSA and are non-contiguous systems to the overall electrical supply provided by TVA. A peak-shaving power-generation facility, built in 2005 at Primary Substation #2, consists of four natural gas powered generators rated at 770 kilowatts (kW) each for a total capacity of 3 megawatts.

The installation also has a number of on-site standby generators serving a variety of purposes. These generators operate using a wide array of fuel sources including natural gas, gasoline, diesel and propane. An inventory of generators was conducted in 2005 indicating a total capacity of 12,869 kW.

A total of approximately 300 meters are currently planned and all but about 30 have been installed. Buildings associated with the von Braun complex have not been able to be scheduled for power outage in order to install new meters. All meters have communication ability ("smart" capabilities) but the enhanced capabilities are not yet functional. They will be in the future. A project has been initiated for all buildings over 29000 SF, reimbursable customers, and some additional large buildings that will roughly double the number of new meters. Energy accounting software is being considered to manage meter data.

Comprehensive Energy and Water Master Plan



Legend

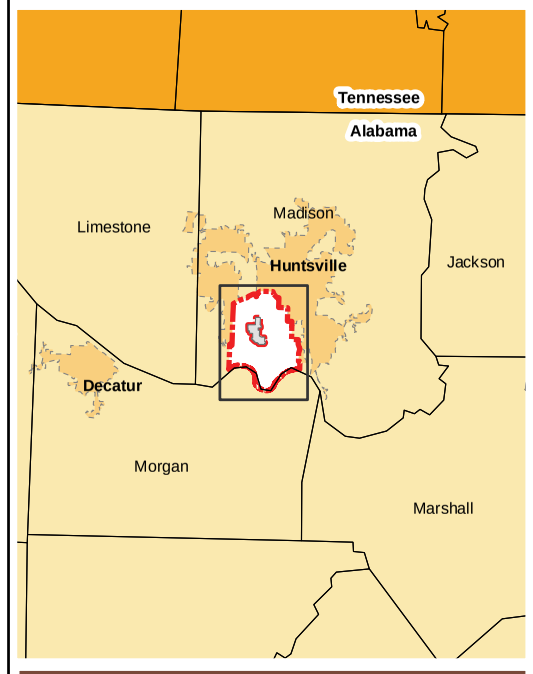
- Primary Electrical Substation
- Switching Station
- Substation From Primary 1
- Substation From Primary 2
- Overhead Electric Line
- Underground Electric Line
- Electric Metered
- Surface Water
- Building
- Redstone Arsenal
- Marshall Space Flight Center
- Urban Area

N W E S

0 1,500 3,000 6,000 9,000 12,000 Feet

Electrical Infrastructure
Figure 3-2

Version: Prefinal | Date Created: October 2009



Redstone Arsenal
Huntsville, Alabama

3.1.1.2 Consumption

The consumption intensity of electricity on RSA has increased 12.3% from 2003 to 2008. The installation consumed 233,611 megawatt-hours (MWh) of electrical power during FY08. The increases are driven by the need for better maintenance, shifting of some energy loads from steam to electricity and natural gas, as well as variability in weather and installation activity. A portion of the increases may also be attributed to the construction of new facilities with energy consumption intensities higher than anticipated. However, the number of facility audits has doubled from 2007 to 2008. The data collected by these audits should reveal inefficiencies that could be corrected to reverse this upward trend.

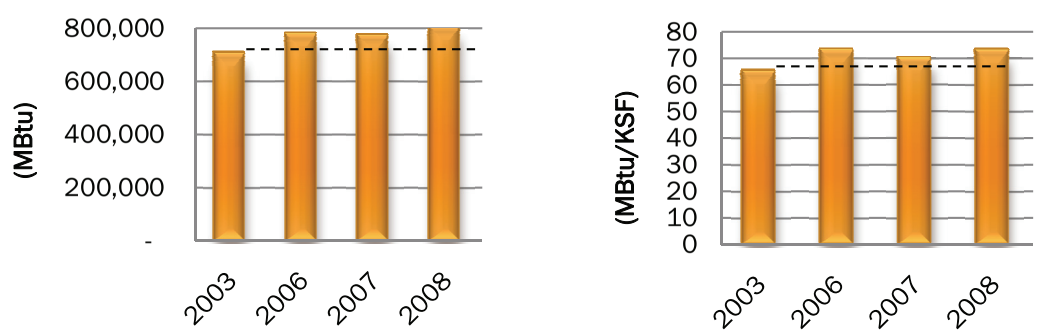


Figure 3-3 Annual Electricity Consumption and Consumption Intensity

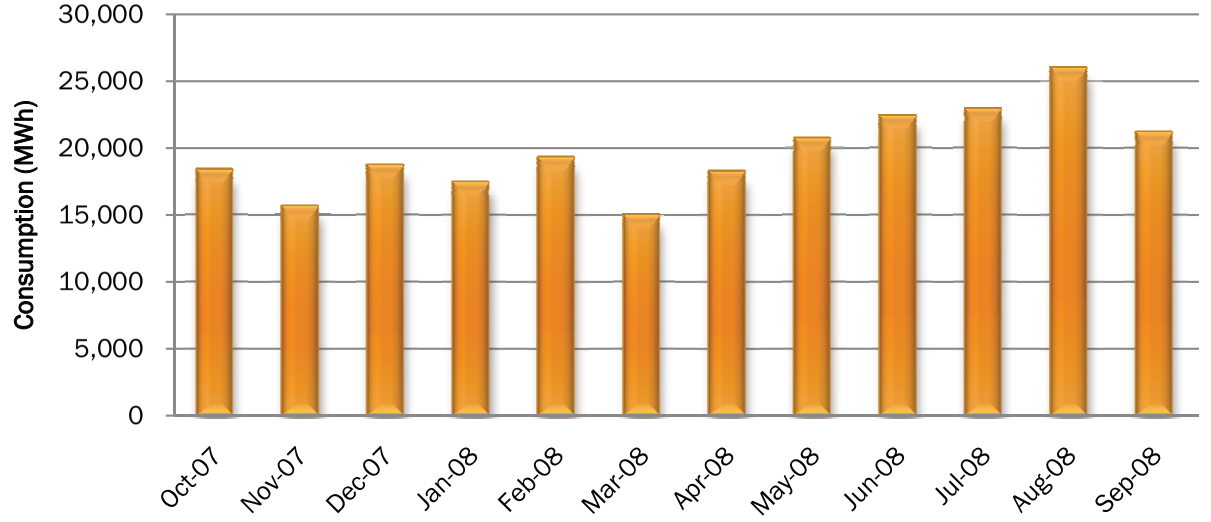


Figure 3-4 Electrical Consumption FY08

3.1.1.3 Planning Tools and Audits

Southeast Region Installation Management Command (IMCOM) has commissioned a study of renewable energy resources for installations in the region. A draft report suggests that the availability and viability of wind, solar, and geothermal energy are limited in the Southeast. If these initial findings prove true for RSA, they will need to focus on reducing fossil energy consumption first through efficiency and then by focusing on non-fossil supply technologies such as biomass generation, waste-to-energy, and perhaps nuclear energy. These efforts will likely be through partnerships with the private sector. RSA, by virtue of its off-site steam supply from the Huntsville Solid

Waste Disposal Authority (SWDA) waste-to-energy plant, has substantial non-fossil energy supply but cannot take credit under EPAct 2005 because the energy is used for steam and not electric power.

Although there has been little progress toward a renewable electricity supply at RSA, a number of projects are underway that are building a foundation for growth in renewable supply at the installation and in the Southeast Region of IMCOM as a whole. Despite initial report findings of limited renewable resources in the region, RSA is currently evaluating opportunities for deploying solar walls and solar water heaters. Plans are also in place to include a pilot for a geothermal heat pump in an expansion of Bldg 3644 (PEO Space & Missile Facility). The geothermal technology being included in the expansion will reduce the heating and cooling loads for the expanded facility using a renewable energy source.

2004 Site-Wide Facility Energy Decision System Analysis

Pacific Northwest National Laboratory (PNNL) completed a site-wide energy assessment at RSA in 2004. This assessment used the Facility Energy Decision System (FEDS) model to determine how energy is consumed at RSA, identify the most cost-effective energy retrofit measures, and calculate the potential energy and cost savings. FEDS is a fuel-neutral, technology independent, comprehensive method for quickly and objectively identifying building energy efficiency improvements that offer maximum savings. PNNL engineers collected information from 35 representative buildings, central plants, other energy systems, and energy-related information and data for input into the FEDS model. The analysis process includes calculating pre- and post-retrofit consumption, initial and recurring retrofit costs, value of the change in annual energy, demand, and annual Operations and Maintenance (O&M) requirements, and net present value of the retrofits. The economic results were based on appropriated funds and alternative financing (e.g., Energy Savings Performance Contract [ESPC]) to implement the energy projects. The alternative financing economic input assumptions are for generic ESPC financing to illustrate the differences that the source of capital makes on the technology choices. The full list of opportunities included 310 cost effective energy and cost reducing retrofit measures.

3.1.1.4 Overall Assessment

As indicated in Figure 3-3, electricity consumption intensity at RSA has increased from the FY03 baseline established in EPAct 2005. The upward trend may be reversed as audits and increased metering identify consumption rates and potential inefficiencies. This could be accomplished through renewed focus in eliminating inefficient energy practices and prioritization of energy efficiency projects.

3.1.2 Steam System

3.1.2.1 Supply and Distribution

RSA purchases steam from a waste-to-energy plant owned by the Solid Waste Disposal Authority (SWDA) and operated by Covanta Huntsville, Inc. During FY08, RSA purchased nearly 515 billion British Thermal Units (Btu) of steam energy from the Huntsville plant at a cost of $11 million. The waste-to-energy steam plant is located on the east side of the installation just outside the installation boundary. The plant uses up to 690 tons per day of municipal solid waste, commercial waste and limited amounts of dried sewage sludge to produce heat for steam production. Two natural gas fired mass-burn furnaces reduce the waste to 10% of its original volume before it is shipped to the local landfill for environmental processing and disposal. The waste-to-energy plant provides steam through two metered entry points (primary metering points A and B) and subsequently through a distribution system on RSA that has a combined length of over 29 miles. An estimated 45% of steam energy is lost in the distribution system. Steam usage and costs are measured at primary metering points A and B.

Steam is purchased under a “take-or-pay” contract that requires a minimum purchase of steam per month, whether or not RSA actually uses this amount of steam. This “take-or-pay” contract includes a base rate for steam below the required minimum purchase amount and a high capacity charge for amounts over the minimum. Current strategies for steam system improvements take into account the cost implications of the contract.

There are also eleven on-post steam production plants that serve individual or groups of facilities proximally located to each of the plants. These plants use natural gas or fuel oil and have a total steam capacity of 217,000 pounds-per-hour.

3.1.2.2 Consumption

Consumption intensity of steam on RSA has decreased dramatically since the 2003 baseline, with 2008 consumption 24.8% lower than that in 2003. RSA is well ahead of the mandated glide path in the steam system infrastructure. Energy improvement projects since 2005 have focused primarily on the steam system and have been successful thus far. The installation consumed 515,000 MBtu's of steam energy in 2008 and has opportunities to reduce consumption even further through continued distribution system repairs.

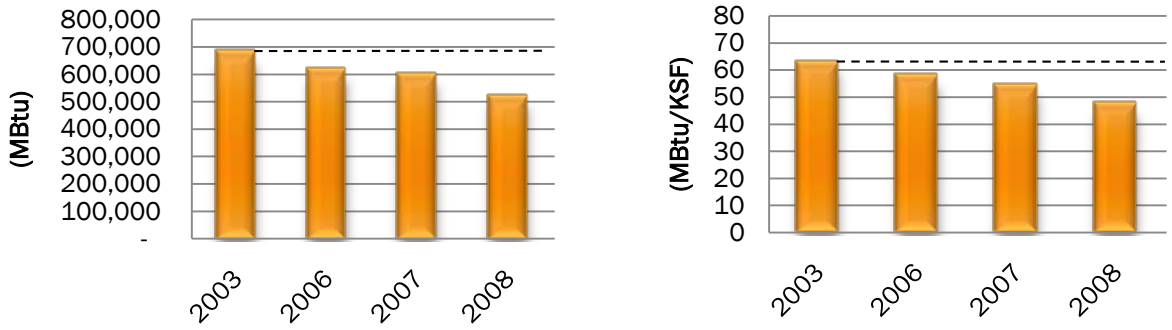


Figure 3-5 Annual Steam Consumption and Consumption Intensity

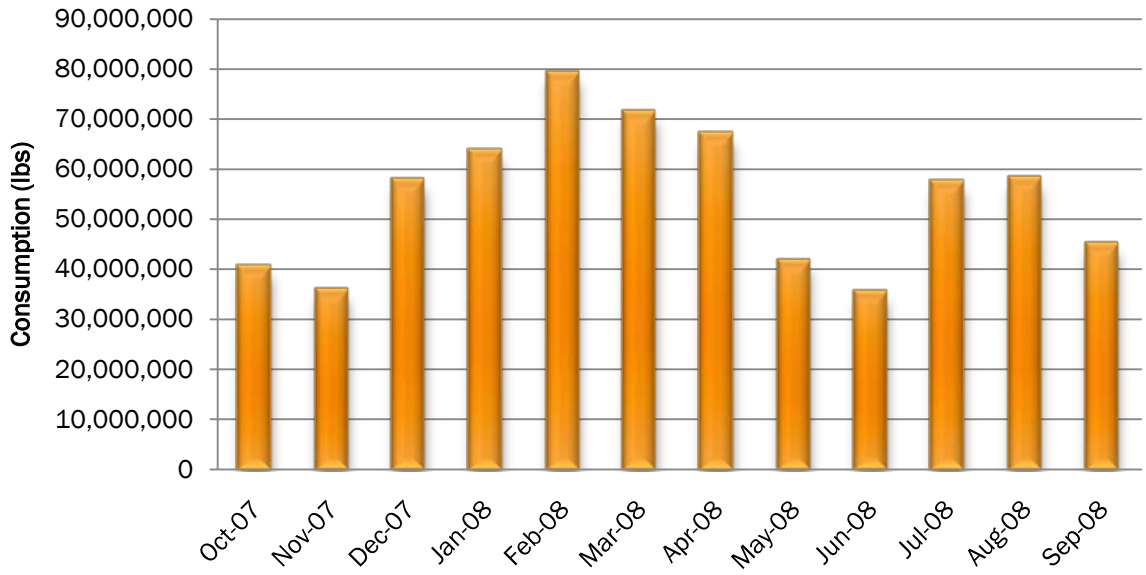
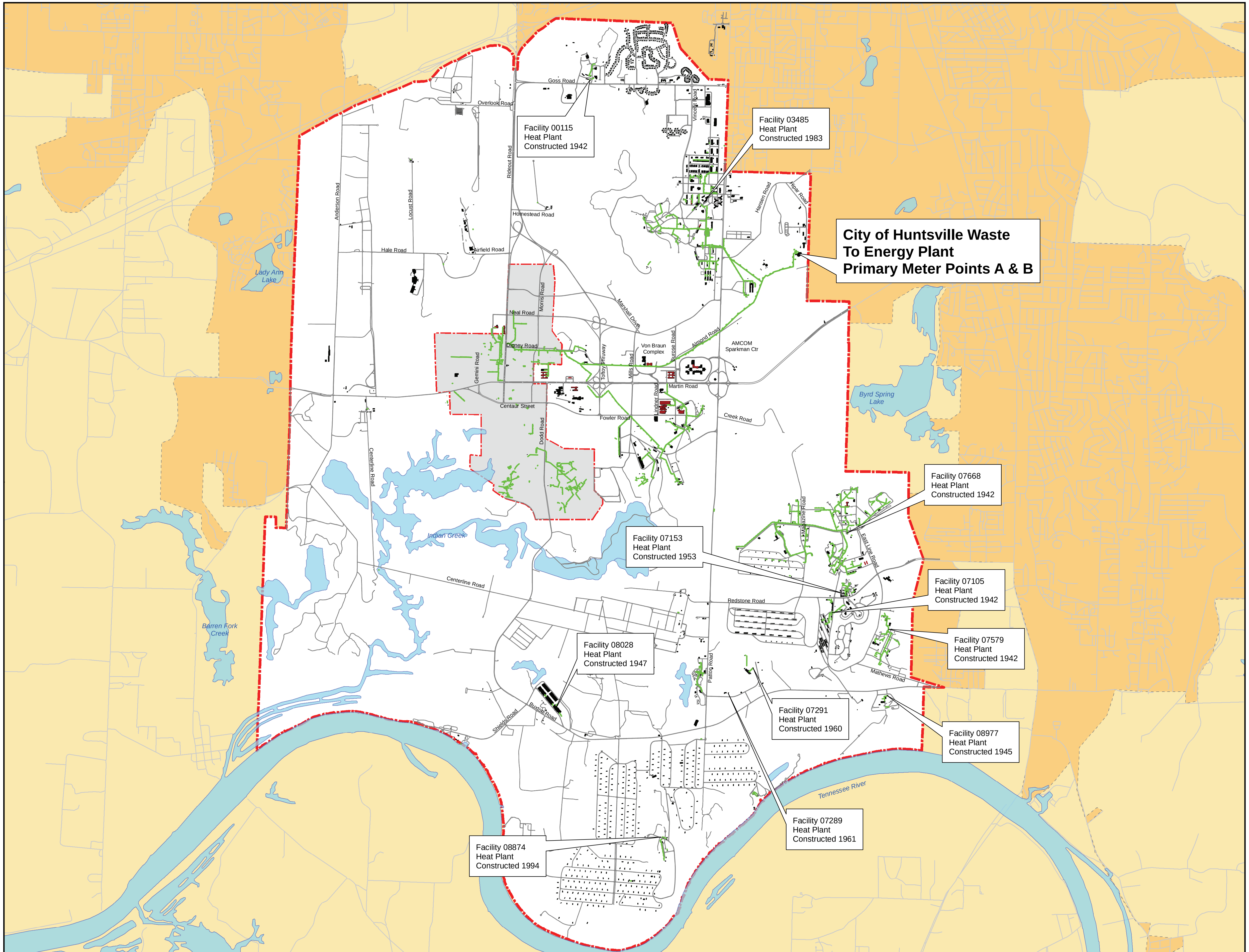


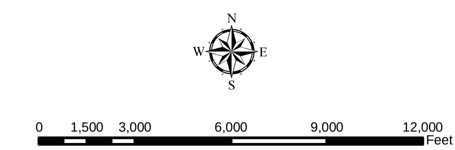
Figure 3-6 Steam Consumption FY08



Comprehensive Energy and Water Master Plan

Legend

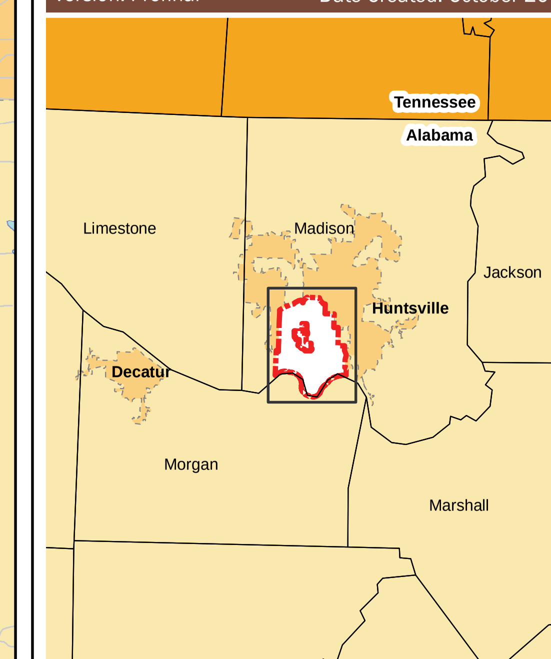
- Steam Line
- Steam Metered
- Surface Water
- Building
- Redstone Arsenal
- Marshall Space Flight Center
- Urban Area



Steam Infrastructure

Figure 3-7

Version: Prefinal Date Created: October 2009



Redstone Arsenal
Huntsville, Alabama

3.1.2.3 Planning Tools and Audits

2004 Redstone Arsenal Steam System Options Evaluation

Following the FEDS energy assessment conducted in 2003 and 2004, an energy planning workshop was funded by the Office of the Assistant Chief of Staff for Installation Management (OASCIM) to evaluate future energy conservation measures and other energy-related plans. One of the key outcomes from the workshop was the realization that the most important action item for RSA was to better understand how to manage the steam system to prevent waste and plan for the future. The study concluded that through the remainder of the take-or-pay steam contract (2014), RSA could optimize its steam contract by first reducing winter steam loads down to the take-or-pay minimum with cost effective technologies, and then seeking to build summer steam loads up to the take-or-pay minimum to avoid paying for steam that is not being used. Another option that was presented in the study, and is currently underway, is to selectively prune branches from the steam distribution system and install building-level boilers in the pruned areas. The premise is to identify areas of the base where the steam density index, or building floor area divided by length of steam supply distribution piping, is low enough to justify pruning without causing total consumption to exceed the take-or-pay minimum.

2007 Detailed Energy Study by TVA Energy Services

The primary purpose of this study, completed in 2007, was to evaluate the feasibility of removing, or pruning, selected facilities from the base-wide central steam distribution system and allow the heating, ventilation and air conditioning (HVAC) systems for these buildings to operate independently using natural gas or electricity to supply needed heat. The scope of this study was to evaluate 72 buildings at RSA to determine potential energy conservation measures (ECMs) in areas selected for pruning of the steam distribution system. The audit process involved analyzing utility bills to determine patterns in energy use, followed by site visits to gather data and observe operations. The study evaluated the existing lighting, energy management systems and controls, HVAC systems, and architectural design of facilities to determine ECMs. The report details the findings from the audit including system descriptions, ECMs, and financial impact of the identified ECMs.

3.1.2.4 Overall Assessment

The consumption of steam on RSA has decreased greatly due to the progressive repairs made on the distribution system. Progress is attributable to the steam system being assigned highest priority in the energy management plans that were generated after the PNNL FEDS study in 2003-2004. Diligent action following those plans has produced measureable improvements that are well ahead of the 3% annual reduction schedule required by EISA 2007 and EO 13423. If RSA continues to reduce steam consumption and SWDA is agreeable to a less restricting contract in 2014, it may be economically reasonable to continue centralized steam production from the waste-to-energy plant.

Steam Escaping From Distribution Lines

3.1.3 Natural Gas System

3.1.3.1 Supply and Distribution

RSA purchases most natural gas through the Defense Energy Support Center (DESC) and a third-party broker, Interconn Resources. Huntsville Utilities is paid a transportation tariff on these accounts. During FY08, RSA purchased over 350 million cubic feet (cu ft) of natural gas at a cost of $3.7 million.

The natural gas site distribution system for RSA is limited to two 12" 50 pounds-per-square-inch (PSI) gas mains, located near Patton Road and north of Martin Road. The existing natural gas lines are being replaced due to corrosion caused by ineffective cathodic protection. The two 12" mains are to be replaced by two new 8" mains. The total length of natural gas pipelines is approximately 348,000 linear feet (LF); the status of which is as follows:

- 46,000 LF of abandoned lines
- 233,000 LF of main lines
- 69,000 LF of service lines

Eighty-eight (88) gas meters, located throughout the Garrison, represent a capacity of 631,590 cu ft/hr.

3.1.3.2 Consumption

Natural gas consumption intensity on RSA has increased 17.2% from 2003 to 2008. RSA consumed approximately 343,000 MBtu of natural gas in 2008. The increases are driven by the need for better maintenance, shifting of some energy loads from steam to electricity and natural gas, as well as variability in weather and installation activity. A portion of the increases may also be attributable to the construction of new facilities with energy consumption intensities higher than anticipated. The addition of the peak-shaving natural gas power-generation facility installed on Primary Substation #2 in 2005 may also account for a portion of the increase.

A maximum monthly usage of 46.4 million cu ft was recorded for January and a minimum of 13.6 million cu ft in July. The power-generation facilities in the Sparkman Center, Wernher von Braun Complex, and Primary Substation #2 are large natural gas consumers. The largest single consumer of natural gas was Building 7668, which had an annual estimated consumption rate of 54.7 million cu ft, 22% of the total post-wide consumption rate. This building houses the steam heat plant operated by the City of Huntsville.

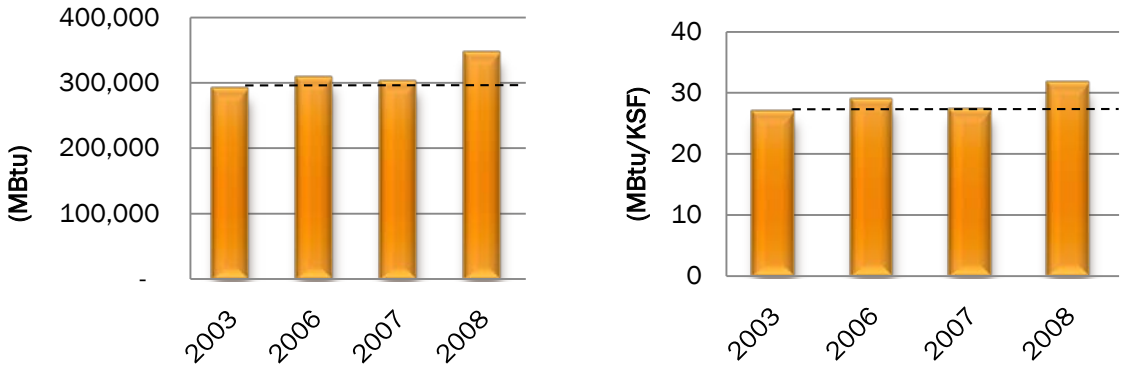


Figure 3-8 Annual Natural Gas Consumption and Consumption Intensity

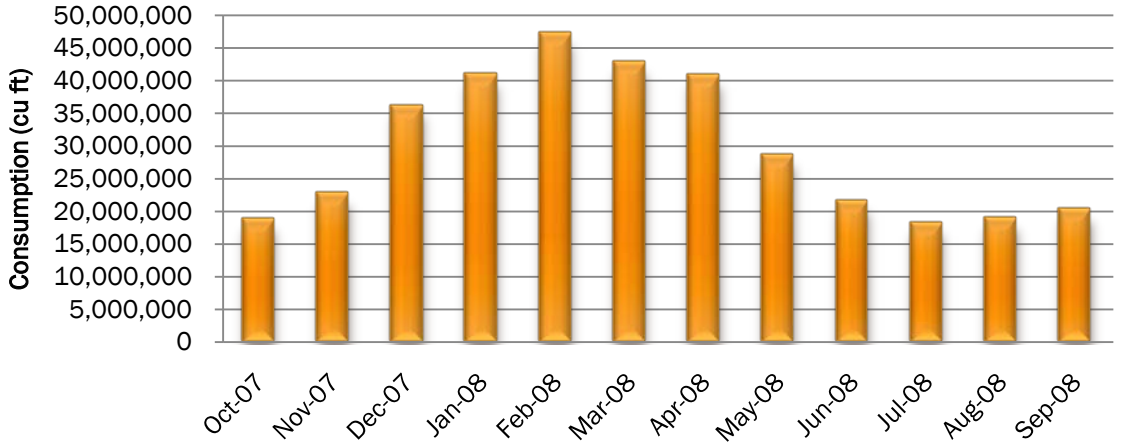


Figure 3-9 Natural Gas Consumption FY08

3.1.3.3 Planning Tools and Audits

Using the TVA United Energy Service Contract (UESC), RSA plans to audit the government owned boiler plants on the installation and the associated square footage served by each one for feasible energy conservation measures. It is anticipated that at least some of the plants will be decentralized.

3.1.3.4 Overall Assessment

Although Figure 3-8 depicts an increasing trend in natural gas consumption, RSA anticipates a trend reversal in the upcoming years, primarily due to facility audits. Continued reduction could potentially lead to using natural gas as a supplemental power-generating resource in the future.

3.1.4 Fuel Oil and Propane Systems

3.1.4.1 Supply and Distribution

Propane is purchased and stored in tanks that are located throughout the Garrison for local usage. The total propane storage capacity is 21,250 gallons. Supply of propane to RSA is not centrally managed.

In FY08, RSA purchased 184,379 gallons of #2 Fuel Oil. Fuel oil is used, in most cases, as a fuel alternative to natural gas in central boiler plants. The purchased fuel oil is delivered and stored locally. Fuel oil tanks on RSA provide a total of 120,000 gallons of storage.

3.1.4.2 Consumption

The consumption of fuel oil, propane, and other fuels on RSA represents a small fraction of the overall energy usage on RSA. Most fuel consumption is for the generation of steam in on-site boiler plants. Fuel consumption has decreased 9.6% from 2003 to 2008. RSA consumed approximately 26,000 MBtu's in fuels in 2008.

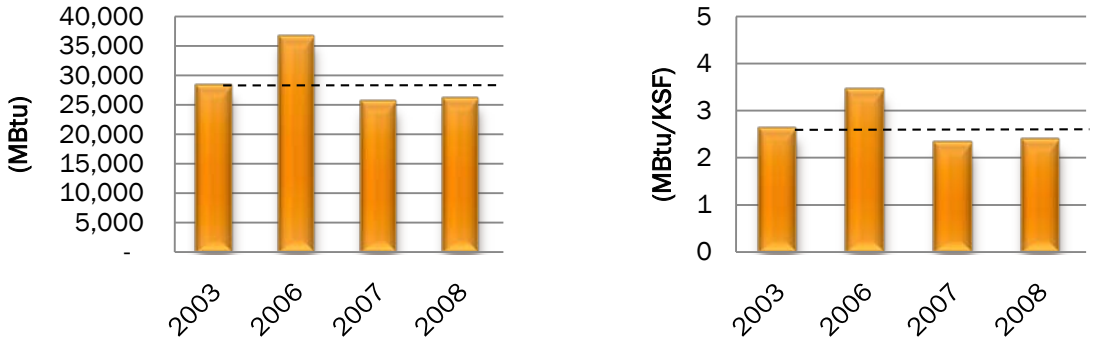


Figure 3-10 Annual Fuels Consumption and Consumption Intensity

Comprehensive Energy and Water Master Plan

Legend

- Natural Gas Main Line
- Natural Gas Service Line
- Natural Gas Metered
- Surface Water
- Building
- Redstone Arsenal
- Marshall Space Flight Center
- Urban Area

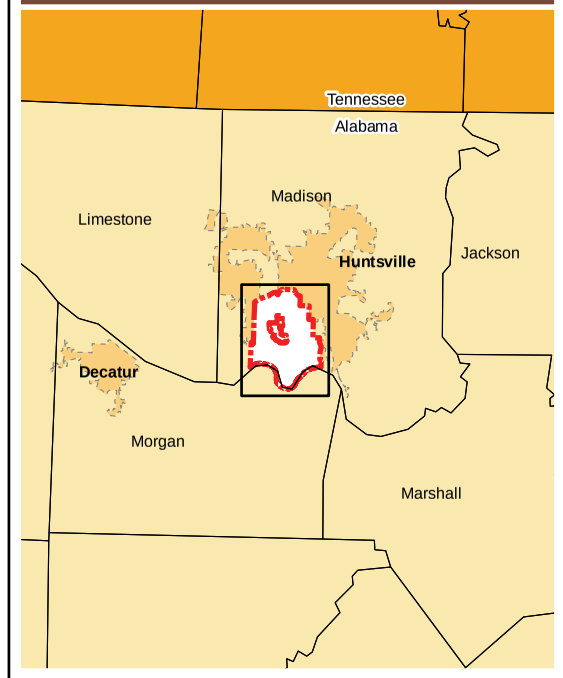
N W E S

0 1,500 3,000 6,000 9,000 12,000 Feet

Natural Gas Infrastructure

Figure 3-11

Version: Prefinal | Date Created: October 2009



Redstone Arsenal
Huntsville, Alabama

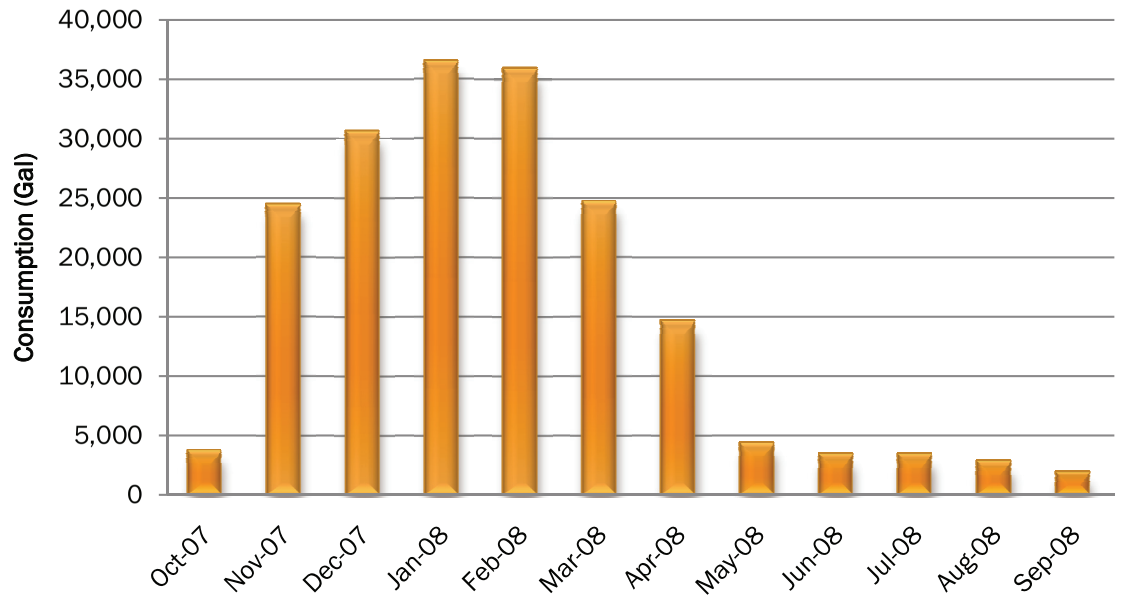


Figure 3-12 Fuels Consumption FY08

3.1.4.3 Planning Tools and Audits

A potential pilot project to test biodiesel as a replacement for fuel oil in one of the government owned boiler plants is under study. If the project is successful, RSA will use biodiesel in all boiler plants that currently use fuel oil.

3.1.4.4 Overall Assessment

Although the impact of fuels on overall energy consumption is minimal, continued reduction in fuels will enable RSA to use these resources as secondary supply in the future.

3.2 Water Systems

The federal mandates that drive the CEWMP program are oriented toward reducing the cost and waste associated with water that is purchased, produced and consumed by the installation. The criteria for establishing goals and tracking water conservation compliance include potable water system consumption and cost, as tracked in the Army Energy and Water Reporting System (AEWRS). Non-potable water supplies and systems are also considered in the CEWMP planning process for their potential as substitutes for potable water uses.

3.2.1 Potable Water System

Redstone Arsenal is equipped with a self-contained potable water supply and distribution system which is Government owned and entirely contained within the limits of the installation. Additionally, the RSA water system has four connections to the City of Huntsville water system, which currently serves as the primary source for potable water at the installation. Furthermore, Redstone Arsenal is equipped with an integrated industrial water production and distribution system that serves as the raw water supply for one of two on-site potable water treatment plants. For the purposes of the CEWMP water use reduction goals, the industrial water system is not classified as part of the potable water system.

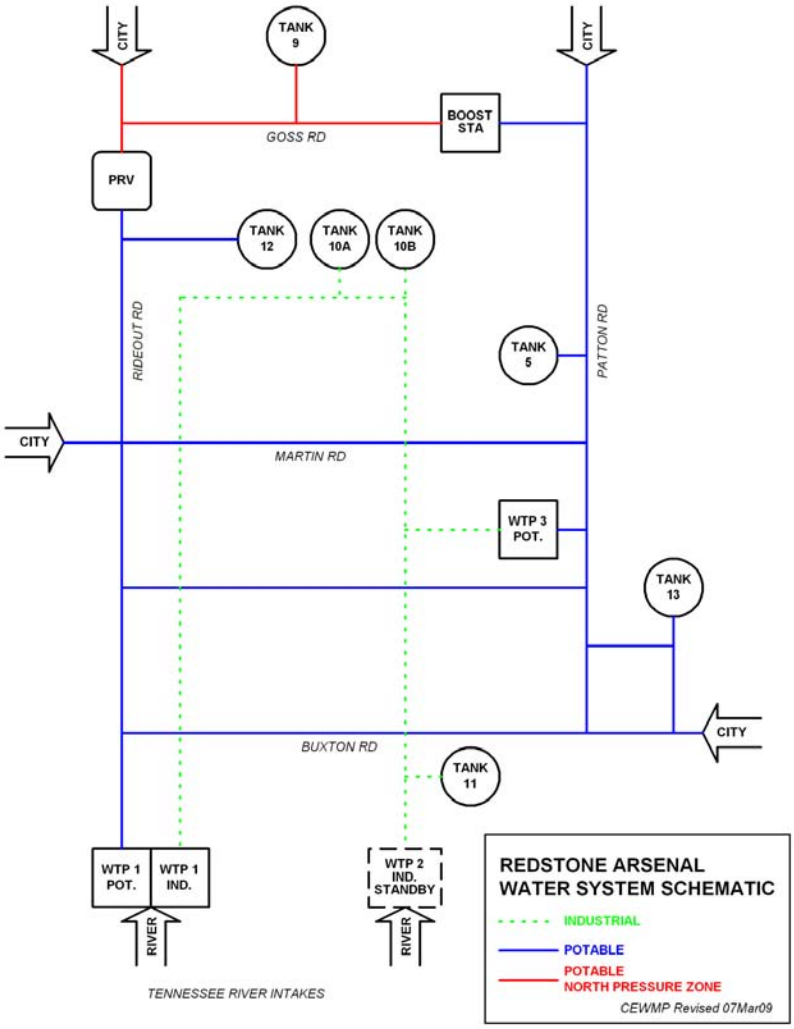


Figure 3-13 Redstone Arsenal Water System Schematic

Since 2006 the potable water system has been supplied primarily by the City of Huntsville. Additionally, RSA has three on-site wells and two potable water treatment plants (WTPs) that are maintained in a standby status to produce supplemental water should the primary source become unreliable or there is need for water source security. There are also two on-site industrial water treatment plants serving as a partial source for potable water plant influent in addition to providing non-potable water to numerous industrial user components.

Figure 3-13 provides an overview of the active components of both potable and industrial water systems, including supply, treatment, distribution and storage features.

3.2.1.1 Supply and Distribution

Supply

Potable water supply for Redstone Arsenal is comprised of off-site water purchased from the City of Huntsville, on-site water sourced from the Tennessee River, and two wells located at remote buildings. Excluding the purchased water, the developed on-site raw water supply capacity totals 40.9 million gallons per day (MGD). A summary of available water supplies for Redstone Arsenal follows, keeping in mind that the flow ratings are the current raw water supply capacity of each source:

- City of Huntsville low pressure zones (3 connections)
- City of Huntsville high pressure zone (1 connection)
- Tennessee River Intake at WTP No. 1 - 27.5 MGD
- Tennessee River Intake at WTP No. 2 - 12 MGD
- Building 5107 Well - 1 MGD (remote)
- Building 6105 Well - 0.4 MGD (remote)

Tennessee River Intake For Water Treatment Plant No. 1

City of Huntsville

The Redstone Arsenal off-site supply from the City of Huntsville potable water system includes three distribution system connections to the low pressure zones, and one distribution system connection to the high pressure zone. The City of Huntsville water system is reportedly sourced from Tennessee River intakes and groundwater wells, and includes ample supply and storage to meet the potable demands of RSA.

Tennessee River

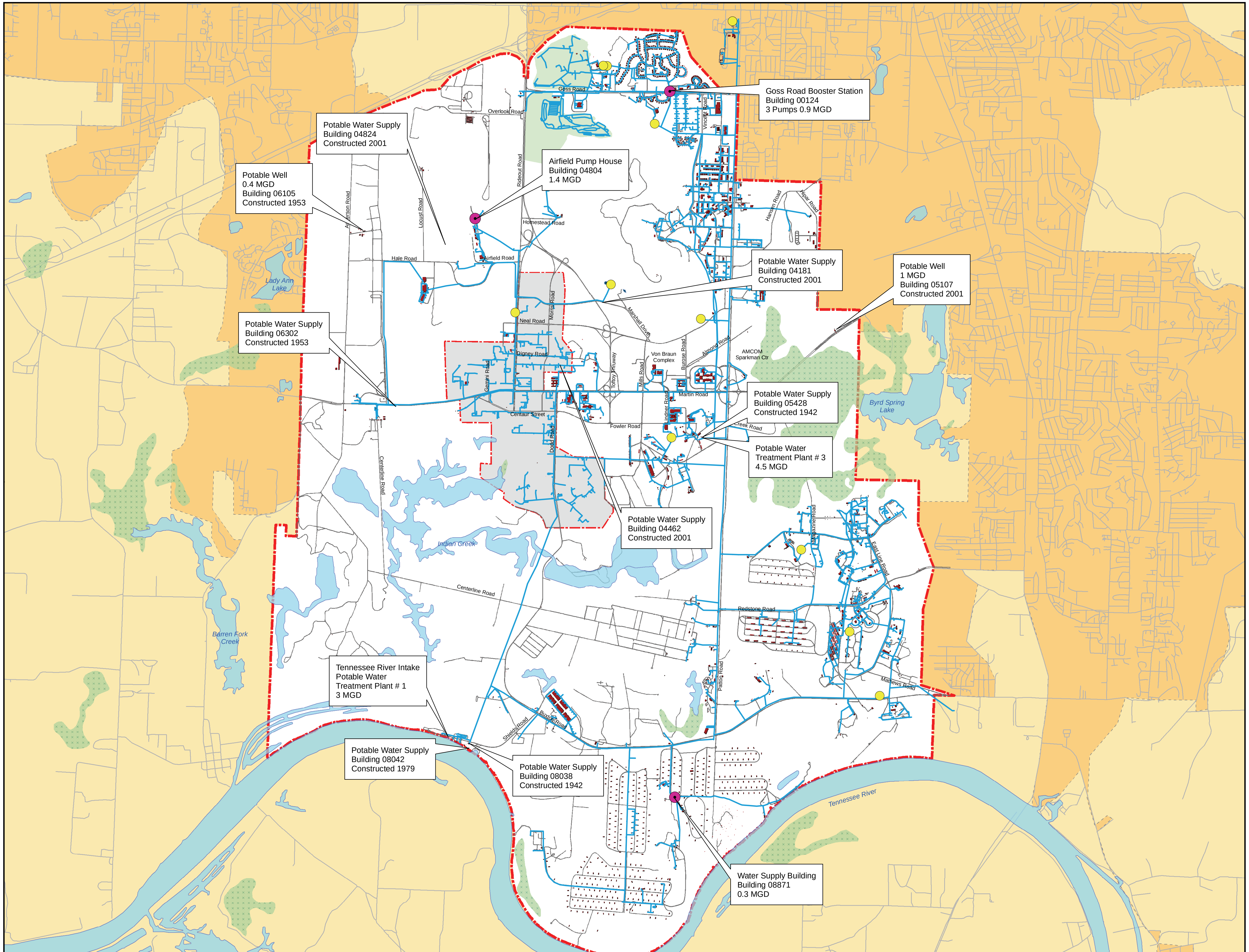
The active on-site supply for raw water is from the Tennessee River at WTP No. 1. Considering the collective industrial and potable water supply pumps housed at this location, with the largest pump out of service, the effective raw water supply capacity rating for WTP No. 1 is currently 27.5 MGD. For the potable water plant alone, the WTP No. 1 intake is capable of pumping 3.5 MGD.

Steel Standpipe Currently in Service and in Good Condition

A standby on-site supply for raw water from the Tennessee River is at WTP No. 2. This plant has the capability of supplying the industrial water system, which in turn, can be used as a raw water source for potable WTP No. 3. As a standby facility, WTP No. 2 is operated periodically in order to assure that it remains in an operable condition. With its largest pump out of service, the plant has a rated raw water supply capacity of 12 MGD.

Wells

There are two wells at locations remote from the RSA distribution system, neither of which have backup power nor pumping equipment. Building 5107 Well supplies the latrine at Gate No. 1, and Building 6105 Well supplies the latrine at Test Area 3. The wells are rated at 730 GPM (1 MGD) and 300 GPM (0.4 MGD), respectively, assuming the pump size was selected based on aquifer drawdown testing.



Goss Road Booster Station
Building 00124
3 Pumps 0.9 MGD
Potable Water Supply
Building 04824
Constructed 2001
Airfield Pump House
Building 04804
1.4 MGD
Potable Well
0.4 MGD
Building 06105
Constructed 1953
Potable Water Supply
Building 04181
Constructed 2001
Potable Well
1 MGD
Building 05107
Constructed 2001
Potable Water Supply
Building 06302
Constructed 1953
Potable Water Supply
Building 05428
Constructed 1942
Potable Water
Treatment Plant # 3
4.5 MGD
Potable Water Supply
Building 04462
Constructed 2001
Tennessee River Intake
Potable Water
Treatment Plant # 1
3 MGD
Potable Water Supply
Building 08042
Constructed 1979
Potable Water Supply
Building 08038
Constructed 1942
Water Supply Building
Building 08871
0.3 MGD
Goss Road
Overlook Road
Rideout Road
Homestead Road
Airfield Road
Hale Road
Locust Road
Anderson Road
Lady Ann Lake
Neal Road
Morris Road
Marshall Drive
Digney Road
Gemini Road
Centaur Street
Dodd Road
Fowler Road
Toftoy Thruway
Mills Road
Von Braun Complex
Burose Road
Martin Road
Lindner Road
Aldridge Road
AMCOM Sparkman Ctr
Creek Road
Hansen Road
Vincent Road
Byrd Spring Lake
Indian Creek
Centerline Road
Barren Fork Creek
Redstone Road
Magazine Road
East Line Road
Patton Road
Mathews Road
Buxton Road
Shields Road
Tennessee River

Comprehensive Energy and Water Master Plan

Legend

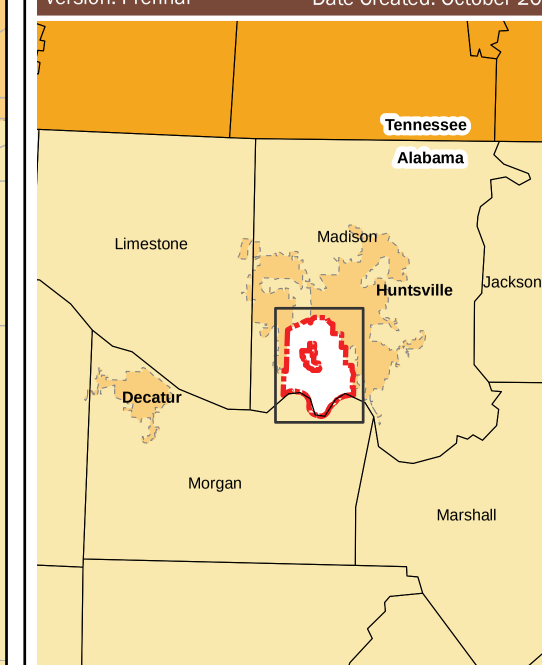
- Booster Station
- Potable Water Tank
- Potable Water Line
- Water Metered
- Reservoir
- Surface Water
- Wetland Area
- Golf Course
- Building
- Redstone Arsenal
- Marshall Space Flight Center
- Urban Area

0 1,500 3,000 6,000 9,000 12,000 Feet

Potable Water Infrastructure

Figure 3-14

Version: Prefinal Date Created: October 2009



Redstone Arsenal
Huntsville, Alabama

Distribution

RSA has separate distribution systems for potable and industrial service. The Potable Water Infrastructure Map (Figure 3-14) shows the geographic locations of the water distribution system. Figure 3-13, Redstone Arsenal Water System Schematic, provides a diagrammatic overview of the general layout and interrelationships between the potable and industrial distribution systems.

The potable water system includes approximately 226 miles of pipe with an average age of 46 years. The distribution system supplies potable water primarily for domestic water use and fire protection purposes, though some industrial and irrigation applications of potable water occur as well.

The potable water system is divided into two pressure zones, as shown on Figure 3-13. Ninety-five percent of the installation is served by the main system pressure zone, which currently floats off of three on-site tanks and additional off-site tanks on the City of Huntsville water system. This pressure zone is currently charged by three connections from the City of Huntsville, and as necessary, is also charged by the potable water high service pumps at WTP No. 1 and WTP No. 3.

The RSA potable water distribution system includes three booster pump stations as follows:

- Goss Road Booster Station, Building 124, 3 pumps, rated at 650 GPM (0.9 MGD)
- Airfield Pump House, Building 4804, 1 pump, rated at 1,000 GPM (1.4MGD)
- Water Supply Building, Building 8871, 1 pump, rated at 200 GPM (0.3 MGD)

Central SCADA Station at WTP No. 2 Provides Real Time Operating Data to Operations and Engineering Personnel

System-wide, the distribution system pressures normally range from 30-75 psi. Buildings greater than two stories high are generally equipped with booster pumps to meet minimum pressure standards. Fire flow studies of the on-site system (prior to city interconnections) reportedly indicate that the system is capable of providing fire flows of 0.1 GPM/SF for all structures exceeding 900 SF, which meets Army fire flow standards. However, under the current configuration (four tanks on line and supply from city), it is likely that an on-site potable water treatment plant will need to be activated to meet a major fire demand. This condition is due to distribution main capacity between the City supply connections and the RSA water system demand centers. Engineers and planners at RSA are in the process of analyzing the distribution system to pinpoint the hydraulic restrictions as the first step in removing them. To that end, a system hydraulic model is currently under development. RSA and the City of Huntsville are also considering the installation of a new 36" water main across the middle of the installation, to connect the East and West city feed points and eliminate hydraulic restrictions to the demand centers.

The potable water distribution system includes over 2300 valves and 950 fire hydrants with an average age of 45 years. There is reportedly no valve exercising program. The system has 120 water meters, which represents less than 0.5% of the structures on the installation. The system has approximately 15 chlorine monitoring stations that were installed in the 1990s. A Supervisory Control and Data Acquisition (SCADA) system monitors and records key distribution system operating parameters including tank elevations, system pressures and chlorine residuals. Most lacking from the SCADA system is flow metering data. A new SCADA system is currently under development.

The aged potable water system is suspected of having numerous leaks. The cast iron portions of the distribution system are subject to cracking during cold weather, in addition to leaks from deteriorated lead joints. The transite pipe is reportedly degraded with age to the point that much of the original wall strength is lost. A recent system-

wide leak detection survey and corrective action reportedly reduced system consumption by 500,000 GPD. However, the previous water production patterns have since returned, so it is suspected that new leaks have emerged.

Water quality is also an issue with the distribution system. Much of the system is comprised of unlined cast iron pipe. Despite the addition of corrosion control chemicals and the execution of system flushing programs, a red water residue continues to exist in portions of the collection system. This condition is exacerbated when the system hydraulics are changed, such as the use of on-site WTPs to supply make up water, flushing and the operation of fire hydrants. A continual challenge with the water distribution system is maintaining chlorine residual in portions that stagnate due to oversized and dead end mains.

Fire Hall Dishwasher Stained by Potable Water After Less Than One Year of Use

Storage

Water storage for the RSA water system consists of on-site and off-site facilities. The on-site facilities are owned by RSA and include finished potable water and industrial water facilities. In addition to storing water for industrial needs, the industrial water storage facilities serve as source water for potable Water Treatment Plant No. 3. A summary of total and active storage capacity at RSA follows:

- On-site Potable Water - 2.8 million gallons (MGAL) Total with 1.3 MGAL Active
- Off-site Potable City of Huntsville - Over 5 MGAL

On-site potable water storage at Redstone Arsenal is comprised of fourteen tanks providing a combined storage capacity of 2.8 MGAL. The tanks are equipped with SCADA level monitoring and cathodic protection. However, based on a cursory inspection from outside of the tank perimeter fencing, some of the tanks are in need of coating rehabilitation. Of the fourteen potable water tanks, four are currently in service. The remaining ten tanks have been taken off line to reduce operation and maintenance demands.

Over 5 million gallons of additional storage is reportedly provided off-site by the City of Huntsville water system, which has tanks located in close proximity to the east and west borders of RSA.

3.2.1.2 Consumption

The potable water system serves a resident population of approximately 4,000 and a daytime population of approximately 32,500. According to AEWRS, the FY08 potable water consumption totaled 718 million gallons, which is an average daily flow of 2.0 MGD. FY08 potable water production cost was reported on AEWRS at $863,000, which is equivalent to $1.20 per thousand gallons.

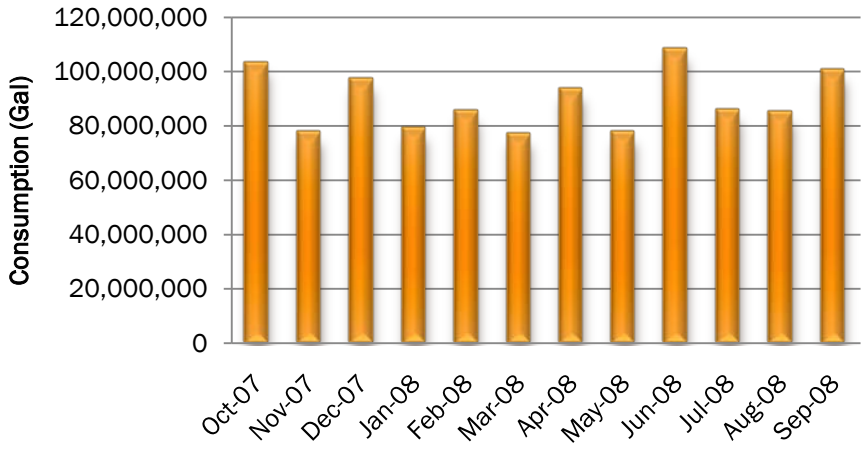


Figure 3-15 Potable Water Consumption FY08

Figure 3-16 provides a Glide Path chart of annual potable water consumption intensity since year 2001, and also portrays the baseline and goal year provisions of Executive Order 13423.

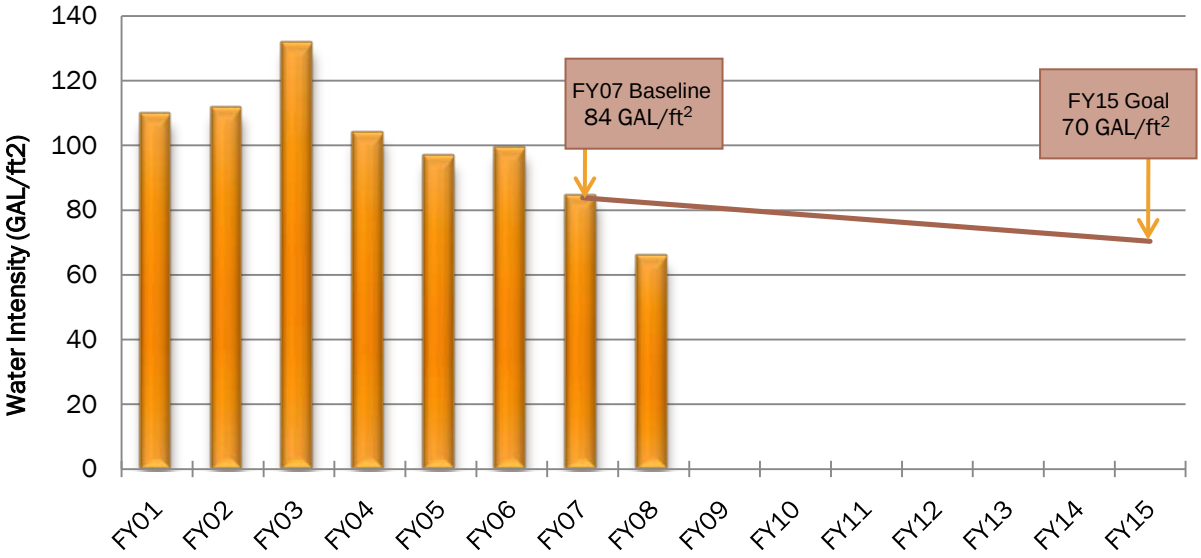


Figure 3-16 Redstone Arsenal Water System Glide Path

Water conservation provisions of Executive Order 13423 establish the FY07 consumption intensity of 84 GAL/ft^2 as a baseline, and select the goal of 2% annual water consumption reduction over eight years, for 16% net water use reduction by FY15. As illustrated by the Glide Path in Figure 3-16, the net FY08 water consumption intensity of 65 GAL/ft^2 already surpasses the FY15 Goal of 70 GAL/ft^2.

As seen in Figure 3-16, RSA potable water consumption intensity since FY01 peaked at 131 GAL/ft^2 during FY03. Coincidentally, the following year was the first year that a formal water management plan was developed for RSA specifically to review and implement the ten Department of Energy (DOE) water Best Management Practices (BMPs). In the five years since, potable water consumption has steadily decreased by a net amount of 49%, resulting in FY08 consumption intensity of 65 GAL/ft^2, or 718 million gallons (MGAL) of total water consumed. There is still opportunity for further reduction in potable water usage. Figure 3-17 illustrates the large portion of water that is unaccounted, some of which is due to leaks in the system.

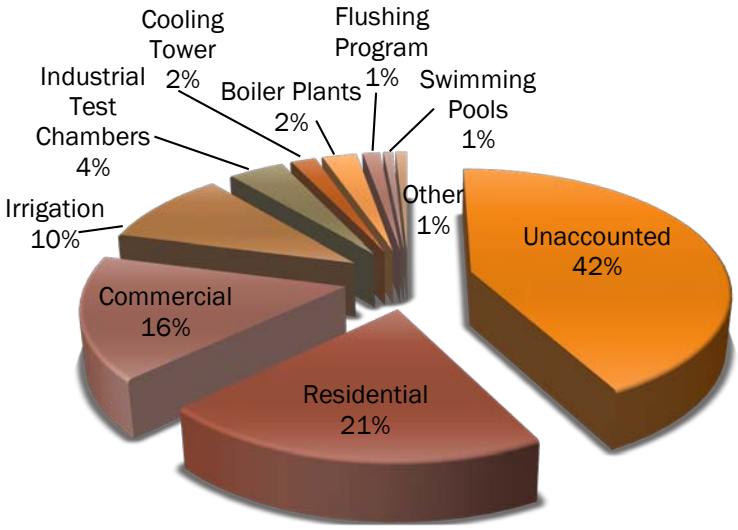


Figure 3-17 FY08 Water Usage Categories

3.2.1.3 Treatment

Finished potable water treatment for RSA is provided at WTP No. 1 and WTP No. 3. The industrial water system serves as the raw water supply for potable WTP No. 3. Therefore, besides producing industrial water for the installation, the industrial treatment component of WTP No. 1 and standby industrial WTP No. 2 also function as pre-treatment processes for the potable water produced at WTP No. 3. The developed on-site potable water treatment capacity totals 8.9 MGD. A summary of water treatment plant delivery capacity at RSA follows:

- WTP No. 1 - 3 MGD Potable
- WTP No. 3 - 4.5 MGD Potable
- Building 5107 Well - 1 MGD Potable (remote)
- Building 6105 Well - 0.4 MGD Potable (remote)

Treatment at the two remote wells consists of hypochlorinators at each well to disinfect and maintain chlorine residuals.

3.2.1.4 Planning Tools and Audits

Structured water management planning studies at Redstone Arsenal initiated with the 2004 Water Management Plan developed by the Department of Public Works. In the following year, a 2005 Long Range Energy Management Plan, also developed by the DPW, updated the water system Best Management Practices (BMP) implementation program established in the 2004 Water Management Plan. The AEWRS includes recorded annual updates in potable water production and cost, and BMP implementation status.

2004 Water Management Plan

Redstone Arsenal prepared a 2004 Water Management Plan including the profiling of water usage categories and analysis of the ten DOE water management Best Management Practices (BMPs). This 2004 Plan calculated usage categories for the Redstone Arsenal water system as follows, using FY03 water consumption data:

- Potable Water Production: 1,418 MGAL
- Leaks, Losses and Unaccounted: 964 MGAL
- Commercial: 152 MGAL

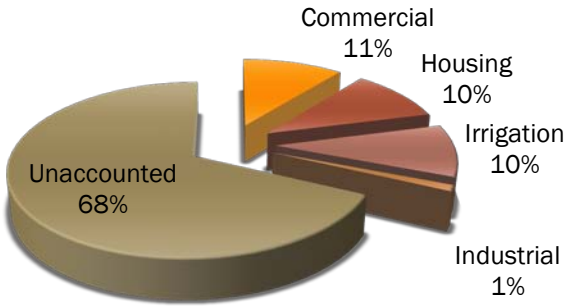


Figure 3-18 Water Usage Categories from the 2004 Water Management Plan

- Housing: 145 MGAL
- Irrigation: 141 MGAL
- Industrial: 16 MGAL

The 2004 Water Management Plan adopted six of the BMPs for active implementation based on applicability to the system and payback period.

2005 Long Range Energy Management Plan

RSA prepared a 2005 Long Range Energy Management Plan (LREMP) which updated the implementation schedule developed in the 2004 Water Management Plan.

The BMP implementation schedule, as updated in the 2004 Energy Management Plan, follows:

- BMP # 1 - Public Information and Education Programs: (non-capital) FY04
- BMP # 2 - Distribution System Audits, Leak Detection & Repair: FY05
- BMP #3 - Water Efficient Landscaping: *For future new construction*
- BMP # 4 - Toilets and Urinals: FY05
- BMP # 5 - Faucets and Showerheads: FY05
- BMP # 6 - Boiler/Steam Systems: (non-capital) FY05
- BMP # 7 - Single-Pass Cooling Equipment: *Currently Investigating*
- BMP # 8 - Cooling Tower Systems: (non-capital) FY06
- BMP # 9 - Miscellaneous High Water-Using Processes: *Ongoing*
- BMP# 10 – Water Reuse and Recycling: *Currently Investigating*

2009 CEWMP Water Usage Category Review

Integral with the implementation of the BMPs recommended in the 2005 LREMP, the RSA professional staff recognized the significance of the originally calculated 68% "Leaks, Losses and Unaccounted" category of the 2004 Water Management Plan, and has since been performing ongoing and systematic evaluations to identify the losses and estimate their respective water usages. By their nature, these investigations are a dynamic and iterative process. Based largely on RSA staff input, and supplemented with field confirmation and data checking, the following results provide a consolidated profile of water usage categories for RSA. This profile shall serve as the foundation for measuring ongoing progress in meeting the water usage goals and objectives of the CEWMP. The FY08 water usage totals are illustrated below, for which the representative chart is provided in Figure 3-17 on the previous page:

- FY 2008 Production: 718 MGAL
- Unidentified Losses and Leaks: 303 MGAL
- Residential: 147 MGAL
- Office/Commercial: 116 MGAL
- Irrigation: 70 MGAL
- Industrial Test Chambers: 29 MGAL
- Cooling Tower Evaporation/Blowdown: 13 MGAL
- Boiler Plants: 18 MGAL
- Flushing Program: 9 MGAL
- Swimming Pools: 5 MGAL
- Fire Training: 3 MGAL
- Sprinklers: 2 MGAL
- Agricultural Leases: 2 MGAL

2009 CEWMP BMP Implementation Review

Since the implementation of BMPs was initiated, potable water usage has steadily declined a total of 39% from FY04 to FY08. Over that time, RSA has implemented the BMPs in greater degrees as described in detail below:

BMP # 1 - Public Information and Education Programs

Public information and education programs were implemented in FY04, and continue as ongoing policy. For example, water and energy management has been institutionalized into the RSA facility manager handbook and orientation program, where each building manager is designated and trained as a building energy monitor.

BMP # 2 - Distribution System Audits, Leak Detection & Repair

A turnkey contract for system-wide distribution system audits, leak detection and repair was completed. The audit portion was conducted over two weeks. Corrective action from this contract reportedly reduced water production by 0.5 MGD (182 MGAL/year) upon completion. Unfortunately, water production quickly reverted to previous levels, indicating that new leaks developed shortly after they were repaired. Recognizing that leak audits are best conducted as an ongoing preventative maintenance program, RSA Directorate of Public Works (DPW) has since procured leak detection equipment for the contracted system operators, and is envisioning that 25% of the system be audited every year.

BMP # 3 - Water Efficient Landscape

This BMP is implemented for programmed new construction and rehabilitation projects as a design convention. Because the RSA industrial water system already provides irrigation water for most facilities within its reach, programming new projects based on this BMP alone has not been considered a priority for reducing potable water usage. For those potable water irrigation systems that currently exist, however, the presence of the industrial water system presents a unique opportunity for RSA to further reduce potable water consumption for the cost of a water main extension.

The golf course is equipped with catchment ponds and an irrigation water well to reduce the use of potable water for irrigation.

BMP # 4 - Toilets and Urinals, BMP # 5 - Faucets and Showerheads

As part of the 2004 Water Management Plan, RSA profiled their facilities for water conserving fixtures, with the intent to implement fixture replacement projects installation wide, subject to fund availability. As a whole, the residential buildings are considered already retrofitted via 2005 capital improvement projects. Implementation for Industrial, Commercial and Institutional (ICI) buildings is currently being studied by a service contractor.

BMP # 6 - Boiler/Steam Systems

The O&M improvements for boiler/steam systems, as recommended by the Army Commissioners of Public Works (CPW) Industrial Wastewater Treatment Handbook, have been integrated into a maintenance contract at RSA. Furthermore, RSA has been analyzing the boiler/steam plant inventory in order to better gauge the viability of retrofit and replacement options.

BMP # 7 - Single-Pass Cooling Systems

RSA has been analyzing the installed industrial facility inventory in order to identify single pass cooling systems. The RSA DPW is engaged in discussions with facility owners to explore the viability of changing the water supply for such systems from potable water to industrial water. These discussions often involve examinations of facility owner concerns over water chemistry process impacts.

BMP # 8 - Cooling Tower Systems

The O&M improvements for cooling tower systems as recommended by the Army CPW Industrial Wastewater Treatment Handbook have been integrated into a maintenance contract at RSA. Furthermore, RSA has been analyzing the cooling tower inventory in order to better gauge the viability of retrofit and replacement options. As with single-pass cooling systems, the RSA DPW is engaged in discussions with facility owners to explore the viability of changing the water supply for cooling tower systems from potable water to industrial water. These discussions often involve examinations of facility owner concerns over water chemistry process impacts.

BMP # 9 - Miscellaneous High Water-Using Processes

With a large industrial customer base, and a large percentage of water use in the "Leaks, Losses and Unaccounted" category, RSA has been methodically reviewing their connected facilities for high water using processes, and estimating the associated water use quantities. As a result, the water profile since the 2004 Water Management Plan has expanded both in detail and level of accuracy.

One of the general conclusions of this effort is that the lack of system-wide customer metering greatly complicates the process of identifying high water using processes. The RSA DPW is anticipating that a properly calibrated hydraulic model currently under development will assist in pinpointing the location of high water using connections. However, full system metering is considered imperative for proper management of system losses.

In addition to the substantial industrial customer base, potential high water using processes to investigate further follow:

- Aircraft wash racks
- Ground vehicle wash racks
- Aircraft maintenance facilities
- Dining Facilities (DFACs) (ice machines reportedly drain potable water to waste continuously)
- Cleaning/laundry services
- Laboratories
- Medical centers
- Steam plant make-up water

BMP # 10 - Water Reuse and Recycling

The golf course is equipped with catchment ponds to capture and recycle surface water for irrigation. Recycling may have potential at wash racks, although the real estate, procurement and operational demands of a wash water recycling plant may be a challenge to justify.

Reuse of sewage treatment plant effluent would require more advanced treatment technologies than currently available at the three existing water treatment plants, at considerable capital and operating cost. It is not recommended as a viable water source.

3.2.1.5 Overall Assessment

The RSA potable water system has received significant enhancements within the past four years which have greatly reduced overall consumption. Due to the age of the system, continuing maintenance and repairs will be crucial to curbing water losses from existing and future leaks. Although the 16% reduction goal by FY15 has already been met, RSA has opportunity to reduce potable water consumption even further through continual application of the BMPs, which will enhance self-sufficiency and decrease supply costs.

3.2.2 Non-Potable Water Systems

An assessment of non-potable water systems is conducted as part of the CEWMP planning process in order to ascertain the potential of existing or future non-potable systems for reducing the consumption and cost of potable water.

Non-potable water facilities at RSA include:

- Centralized industrial water system
- Golf course storm water catchment and irrigation system
- Sewage treatment plant effluent utility water system

3.2.2.1 Supply and Distribution

Supply

The two Tennessee River intakes at WTP No. 1 and WTP No. 2, as discussed in detail in the potable water section, provide raw water supplies for the industrial water system rated for 39.5 MGD.

The golf course irrigation water system is supplied by storm water runoff tributary to the catchment ponds. Thus, the irrigation water supply depends on local precipitation events and is highly variable.

The sewage treatment plant utility water system is supplied by sewage treatment plant loadings which are typically a minimum of 2 MGD as a monthly average.

Tennessee River Intake for Water Treatment Plant No. 2

Distribution

The industrial water distribution system consists of approximately 38 miles of pipe with an average age of 46 years. The distribution system supplies industrial water primarily for industrial use. However, the industrial water system also serves an important function for providing supply water to WTP No. 3. Thus, the industrial water system has a critical role in supplying on-site potable water during high water demand/loss periods, and during fire flow events. The system is generally considered in poorer condition than the potable water system due to a very low priority on system maintenance.

Golf course irrigation water is distributed via irrigation pumps, pipes and sprinklers located at the golf course.

The treatment plant utility water distribution system is a simple on-site combination of pumps, piping and dedicated hydrants, hose bibs, spray nozzles and other process outlets.

Storage

On-site industrial water storage at RSA is comprised of three facilities providing a combined storage capacity of 7.5 million gallons. Seven million gallons of storage is provided via two reservoirs and a steel standpipe provides the remaining 0.5 MGAL of industrial water storage.

Golf course irrigation water is stored in open catchment ponds located at the golf course.

The sewage treatment plant utility water system relies on the plant treatment tanks and continuous influent flow to provide sufficient storage needs for in-plant utility water use.

3.2.2.2 Consumption

Based on FY07 and FY08 datasets, the industrial water consumption averages 870 MGAL per year, for a daily rate of 2.4 MGD. The consumption of industrial water is calculated by totaling the metered industrial water plant production history, and excluding all industrial water subsequently used for potable water production. Therefore the quantities shown in Figure 3-19 do not include industrial water used for potable water production.

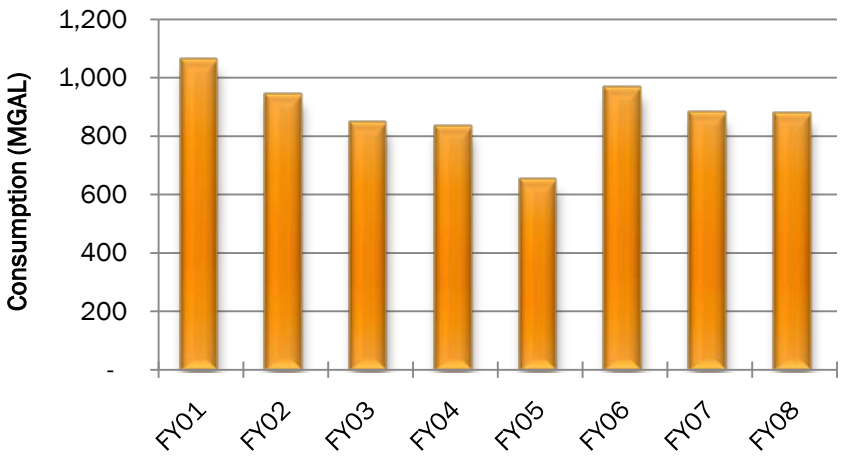


Figure 3-19 Annual Industrial Water Consumption (excludes WTP No. 3 raw water)

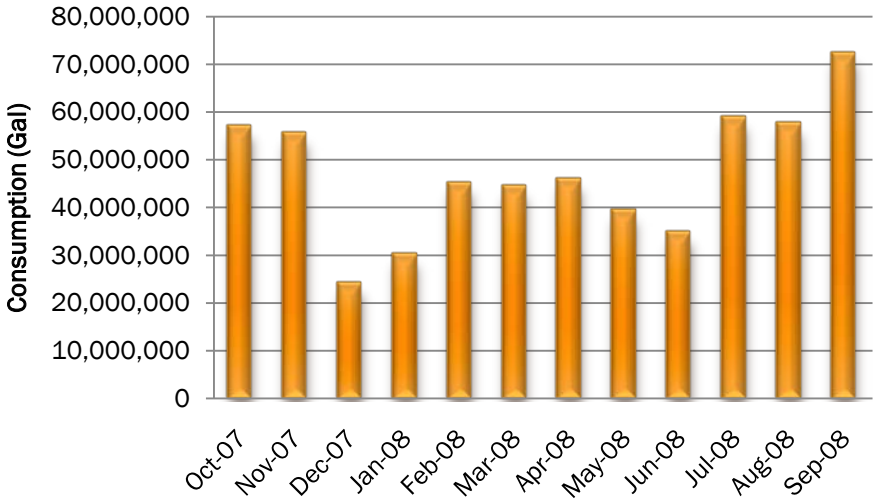


Figure 3-20 Non-Potable / Industrial Water Consumption FY08

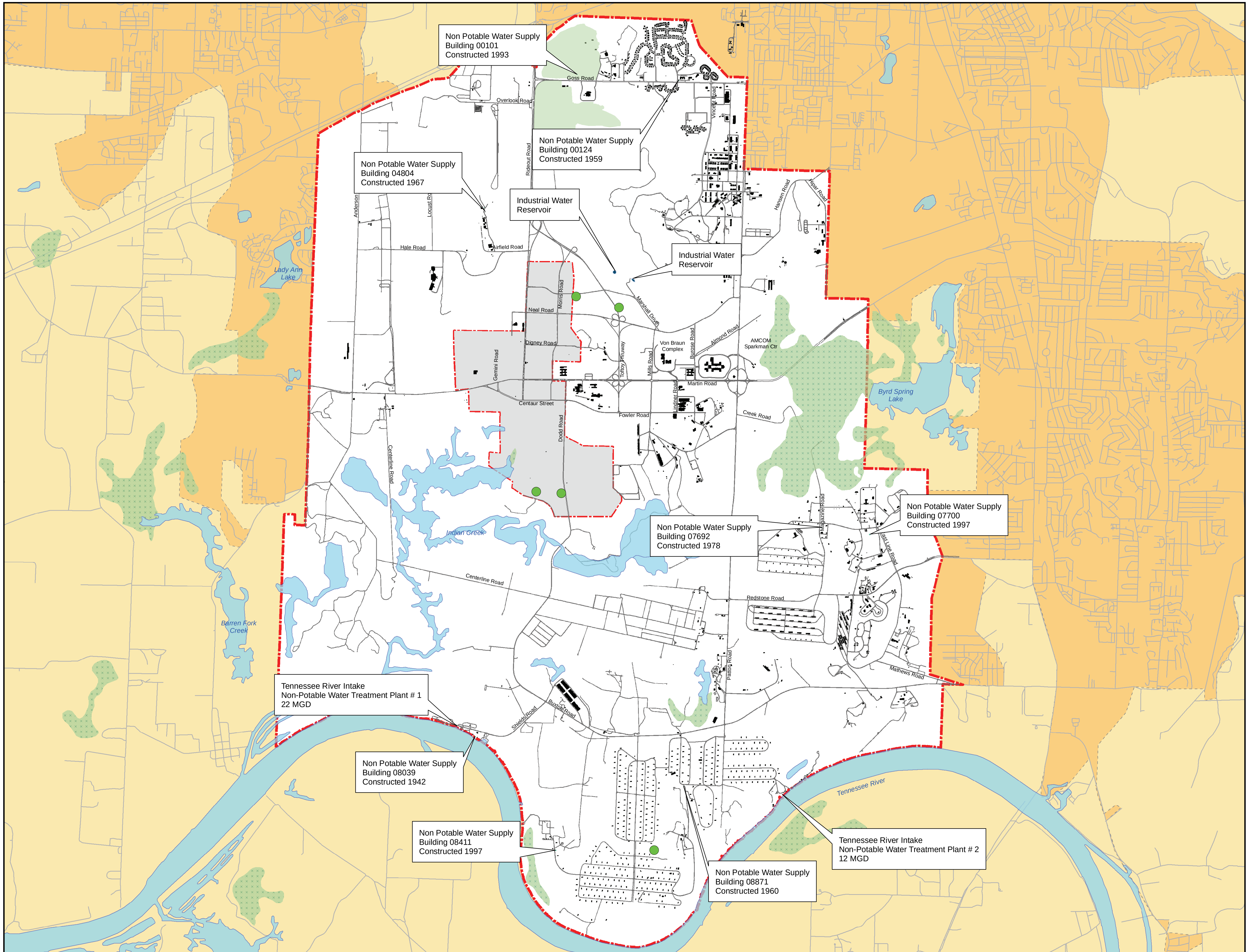
The irrigation water demands of the golf course vary widely with precipitation and season, but are estimated to require 0.2 MGD of potable water as an annual average. It is likely that the catchment system provides 10% to 20% of that average water demand, depending on local precipitation, usage and storage conditions.

3.2.2.3 Treatment

The treatment of industrial water is necessary to remove fine solids from the surface water and minimize the pollutant content. Industrial water treatment occurs at WTP No. 1 and WTP No. 2, which are essentially equivalent in function and vary only in size and condition. The non-potable water treatment plant production capacities follow:

- WTP No. 1 - 22 MGD Industrial
- WTP No. 2 - 12 MGD Industrial

Comprehensive Energy and Water Master Plan


Legend
Industrial Water Tank
Industrial Water Reservoir
Surface Water
Wetland Area
Golf Course
Building
Redstone Arsenal
Marshall Space Flight Center
Urban Area
Non Potable Water Supply
Building 00101
Constructed 1993
Non Potable Water Supply
Building 00124
Constructed 1959
Non Potable Water Supply
Building 04804
Constructed 1967
Industrial Water
Reservoir
Industrial Water
Reservoir
Non Potable Water Supply
Building 07692
Constructed 1978
Non Potable Water Supply
Building 07700
Constructed 1997
Tennessee River Intake
Non-Potable Water Treatment Plant # 1
22 MGD
Non Potable Water Supply
Building 08039
Constructed 1942
Non Potable Water Supply
Building 08411
Constructed 1997
Non Potable Water Supply
Building 08871
Constructed 1960
Tennessee River Intake
Non-Potable Water Treatment Plant # 2
12 MGD
Byrd Spring Lake
Lady Ann Lake
Indian Creek
Barren Fork Creek
Tennessee River
AMCOM Sparkman Ctr
Von Braun Complex
0 1,500 3,000 6,000 9,000 12,000 Feet
Tennessee
Alabama
Limestone
Madison
Huntsville
Jackson
Decatur
Morgan
Marshall

Non-Potable/ Industrial Water Infrastructure

Figure 3-21

Version: Prefinal

Date Created: October 2009

Redstone Arsenal
Huntsville, Alabama

There is no treatment of the golf course irrigation water outside of the natural process provided by the catchment ponds.

The sewage treatment plant utility water system consists of plant effluent which is recycled under pressure for general plant operation and maintenance uses.

Sedimentation Basin At Water Treatment Plant No. 2

3.2.2.4 Planning Tools & Audits

No prior studies or audits were conducted in regards to RSA non-potable water.

3.2.2.5 Overall Assessment

The industrial water system represents a significant asset for the day-to-day infrastructure needs of RSA. This system currently substitutes 2.4 MGD of water that otherwise would be supplied from the potable water system and represents a viable and potentially cost effective alternative water supply to substitute for current potable water consumption in specific non-potable applications.

Considering the importance of the industrial water system to RSA operations, and in order to further reduce the cost of using industrial water as a substitute water source for potable water demands, it is logical and recommended to periodically perform basic leak detection surveys of industrial water system storage and distribution components.

By its nature, the golf course storm water catchment and irrigation system is only as effective as the local precipitation conditions permit. Currently, potable water provisions are in place at the golf course to otherwise meet irrigation water needs. It is recommended that RSA consider the viability of using industrial water as the make-up water source for golf course irrigation, as opposed to the current potable water source.

Recycling the plant utility water from plant effluent is an effective potable water substitute for certain in-plant water demands. The extension of this utility water system for off-site use is likely not viable at RSA due to requirements for state mandated permitting, public health concerns, and limited allowable usage.

Section 4

Opportunities and Constraints

4 Opportunities and Constraints

4.1 Conservation Strategies

Opportunities: The most economically beneficial energy and water strategies focus on conservation of the resources already available. A successful conservation plan develops a cultural change to create an innate awareness of resource limitations across the installation. RSA has a great opportunity to establish education and incentive programs to help develop this cultural change. Such a plan may include:

- Instituting accountability program and incentives for tenants to conserve energy and water
- Setting goals toward Army and Federal Energy and Water Management Awards
- New standard signage promoting lighting and water reductions
- Adoption of aggressive standards for lighting and water fixtures
- Reinforcement of a "green" attitude through newspaper and billboard advertisements

Sample Signage

Constraints: The main constraint hindering this plan may be a "business-as-usual" attitude in which the mostly civilian, research and development-focused population largely ignores the new policies. Top-level support and dissemination of conservation methods will be crucial to overcoming this obstacle. Society as a whole is slowly adopting the "green" attitude, and this mindset should be reinforced within the installation.

Opportunities: An additional opportunity to conserve both energy and water resources is through continued focus on metering. RSA's collection of utility meters is limited to those that are read manually rather than remotely, and many buildings still remain that are not metered at all. According to RSA's most current metering plan, approximately 300 electric meters are to be in place by FY10. On a greater scale, water meters for buildings and main distribution lines are lacking in most areas, with almost half the total potable water usage unaccounted for. Bolstering the overall metering scheme on RSA will allow the energy manager to identify high-use energy and water consumers.

Constraints: The only constraints for a completely metered installation are funding and prioritization. However, an understanding from those who allocate funds that electricity meters are mandatory by law (EPAct 2005) on all federal buildings by 2012 should raise the priority of metering projects.

Opportunities: For energy specifically, RSA has the opportunity to audit and ensure maximum efficiency from existing facilities, and enforce efficiency standards of future buildings. The installation can develop staff training and implement measures to maximize repairs, programming, and scheduling of existing building control systems. RSA can also implement automatic re-commissioning of new facilities after a determined usage time and enforce conformance to Leadership in Energy and Environmental Design (LEED) principles during design and construction. Through this process, facility design teams can consider incorporating energy and water from existing alternative sources, such as waste-derived steam and industrial water.

Opportunities: RSA has the opportunity to increase efforts in identifying and repairing water leaks and losses throughout the installation.

Constraints: The primary limitation will continue to be the antiquated state of most of the water distribution system. Because of its age, the water system will continue to spring new leaks. A vigorous leak detection and repair plan is necessary to curb water loss from the continued deterioration of the system. Increased metering

and repair analysis will allow RSA to justify the cost of water main replacement projects in locations where water loss and repair costs exceed the cost of replacement.

4.2 Supply Alternatives

Table 4-1 presents the different energy and water generation sources with the corresponding opportunities and constraints:

Table 4-1 Opportunities and Constraints

Supply Type	Opportunities	Constraints
Energy		
Electricity	• Current purchased electric power generated by a combination of fossil fuel, hydroelectric and nuclear generation plants.	• The Federal Government has recognized the threat of standard power generation methods to lessen air quality, create waste, and eventually become depleted. Starting in FY10, EPAct 2005 and Executive Order (EO) 13423 require 5% of electrical energy purchased to be from renewable sources, half of which must be from sources developed after Jan 1, 1999.
	• Tennessee Valley Authority (TVA) offers the "Green Power Switch", a program to allocate power generated from wind, solar, and methane gas renewable sources.	• Although renewable sources are free, the technology used to capture the energy is still more expensive than traditional power generation methods. However, increased demand may lead to expanded power production capacity and eventually to lower costs.
	• On-site renewable energy sources will decrease fossil fuel use and increase source security. • Development of biomass technologies may be an alternative energy source.	• Renewable resources in the Southeast United States are generally limited.
	• Conversion of steam from waste-to-energy plant to electricity will decrease reliance on local utility and energy losses from steam system.	• A major shift in energy generation sources will require MILCON-level infrastructure enhancement projects
Steam	• Current steam generation comes from a waste-to-energy plant in nearby Huntsville.	• Because the waste-to-energy steam plant was built before Jan 1, 1999, this energy cannot be used to satisfy the 50% 'new' renewable requirement in EO 13423.
	• Supplemental steam is generated from several natural gas plants located on the installation. Two of these plants, Buildings 8028 and 7291, serve a total of 3 buildings and are known to be oversized with respect to their demand. These systems may be reduced in size, or the steam system can be expanded for other uses.	• A continually deteriorating distribution system will minimize effects of generation enhancements. There is currently no way to monitor the efficiency of boiler plants without requesting reports.
	• Steam systems have been improved in recent years and there are still significant opportunities to optimize demand, reduce the number of leaks, and decentralize where appropriate.	• The purchased steam distribution system is known to incur significant losses and it is likely not practical to completely decentralize steam generation on RSA
Fuel Oil	• There is potential to retrofit generators to run from biodiesel instead of fuel oil.	• Results of a pilot project to replace fuel oil with biodiesel are still pending.
Natural Gas	• In the future, this fuel may be used to supplement power from renewable sources.	• Natural gas prices are vulnerable to fluctuation due to international supply, demand, and natural events. Although this is the cleanest burning source of fossil fuels, there is a finite supply.

Supply Type	Opportunities	Constraints
Water		
Potable	• Infrastructure exists to transition to on-site river supply as main water source and re-establish primary use of owned water treatment plants. • There are potential plans for a 36" city water line across the installation, which will reduce storage needs and resolve water quality issues with city supplies. • There is an opportunity for privatization.	• On-site source will increase plant operations and maintenance costs, but this would be offset by city water purchase savings. There will also be a higher urgency to replace degraded plant infrastructure • A new water line is costly and will only benefit a system supplied by the city. A new line will increase dependence on city water, thereby reducing security. • Privatization will reduce security. A Bill is necessary for funding. Contractor profit represents additional cost.
Non-Potable	• There is potential for increased industrial water supply lines for non-potable applications.	• Cost of supply line installation needs to provide adequate economic payback.

4.3 Security

The Army Energy Security Implementation Strategy published on January 13, 2009 provides specific Energy Security Goals (ESG) toward enhancing the Army's energy security. These goals will be used to analyze the opportunities and constraints regarding energy security.

ESG 1 Reduced Energy Consumption

Opportunities: While there are on-going activities related to energy education and awareness on RSA, the results have been limited and there is room for improvement. Awareness and culture change, while often difficult to achieve, can provide significant energy reductions at a relatively low cost.

Constraints: Customers on RSA are not incentivized to conserve energy, and there is no current mechanism to hold customers accountable for the energy that they use. Also, current maintenance contracts for energy systems contain no incentives for preventative maintenance and efficiency.

ESG 2 Increased energy efficiency across platforms and facilities

Opportunities: There are a number of opportunities to increase the efficiency of on-site power and steam generation plants, as well as to improve energy usage throughout the installation. RSA has a good working relationship and funding mechanism for implementation of cost-effective energy projects through the Utility Energy Services contract with TVA.

Constraints: The procurement process for new facilities results in buildings with energy consumption intensities that are too high to achieve the energy reduction schedule set forth in EO 13423 and EISA 2007. An integrated programming and planning approach will provide an opportunity to ensure new construction projects are not sacrificing efficiency for scope.

ESG 3 Increased use of renewable/alternative energy

Opportunities: There is sufficient availability of real estate on RSA to consider the implementation of a large scale, non-fossil power generation facility. Additionally, TVA offers dedicated electrical power generated from renewable sources to further reduce consumption from conventional power plants.

Constraints: The detailed fuel source, technology, and economic costs are uncertain and would require further studies.

ESG 4 Assured access to sufficient energy supplies

Opportunities: Opportunities exist to make the infrastructure even more robust through on-site renewable energy generation systems. The threat of RSA's single-point-of-failure in steam supply is lessened by the installation's current project to prune facilities from the steam system and install additional natural gas lines and boilers.

Constraints: The opportunity to encourage a more robust infrastructure is reliant on technological advancements and a focus on energy funding. RSA's reliance on the Huntsville waste-to-energy plant for steam creates a single-point-of-failure in which mission shortfalls will occur if the supply is terminated.

ESG 5 Reduced adverse impacts on the environment

Opportunities: Through sustainable design, efficiency projects and a focus on renewable energy procurement, RSA can significantly reduce the amount of energy created by generation sources harmful to the environment.

Constraints: A large portion of fossil fuel use and carbon emissions arise from petroleum-fueled vehicles. This form of pollution will continue until low-emission and electrically-powered cars are more available and included in the RSA inventory.

Section 5

Action Plans & Future Focus

5 Action Plans and Future Focus

This section of the CEWMP offers strategies for reducing consumption of energy and water. Section 6, Project Prioritization List (PPL), provides specific tactics and feasible projects in support of these initiatives.

5.1 Energy

Requirements for energy supply at federal agencies are addressed in different forms by EPAct 2005, EO 13423, and EISA 2007. Table 5-1 shows the progress that RSA has made toward meeting the energy reduction and renewable source targets set by these federal mandates.

Table 5-1 RSA Compliance with Federal Energy Mandates

Requirement	Baseline	Target	FY08 Consumption	% Change	Change Required to Meet Target
Reduction of energy-consumption intensity (MBtu/KSF) by 3% annually and 30% by FY15 **(EO 13423, EISA 2007)**	155.84 (FY03)	132.46 (FY10) 109.09 (FY15)	152.69	-2% (FY03-08)	-13% (FY10) -28% (FY15)
Renewable supply of electricity not less than 3% of demand in FY07-09, 5% in FY10-12, and 7.5% in FY13 and beyond **(EPAct 2005)**	-	5% (FY10) 7.5% (FY13)	0%	0%	+5% (FY10) +7.5% (FY13)
50% of renewable electrical energy (EPAct 2005 target) from sources established after 1 Jan 1999 **(EO 13423)**	-	2.5% (FY10) 3.75% (FY13)	0%	0%	+2.5% (FY10) +3.75% (FY13)

* MBtu/KSF = Million British Thermal Units per Thousand Square Feet

As shown above, RSA must decrease its overall energy consumption in Fiscal Year (FY)10 by 13% (23.4 MBtu/KSF) of the FY03 baseline amount in order to realign with the annual target reductions established in EO 13423 and EISA 2007. The installation must also establish an electrical supply from renewable sources for 5% (40,000 MBtu) of its power demand by FY10 and 7.5% (60,000 MBtu) by FY13 to meet the EPAct 2005 target.

The target set by EO 13423 for 50% of the renewable electrical energy to be generated by new sources (established after 1 Jan 1999) would require 20,000 MBtu in FY10 and 30,000 MBtu in FY13 of qualifying energy to be purchased. For this specific mandate, new renewable energy *other than electricity* (e.g. steam) can count toward this goal. The steam energy produced by the waste-to-energy plant, however, does not qualify because the plant was commercially established in 1990. It cannot be considered a *new* renewable source.

EISA 2007 further mandates that 30% of hot water demand for new facilities and major renovations should be met through the use of solar hot water technology, if determined to be life-cycle cost-effective.

Figure 5-1 shows the FY08 energy consumption profile by source for RSA based on Army Energy and Water Reporting System (AEWRS) data. Fossil energy use (natural gas and fuel) accounts for 21.9% (368,494 MBtu), of facility energy consumption. In order to meet current mandates, it will be important for RSA to address the impact of initiatives on fossil energy consumption.

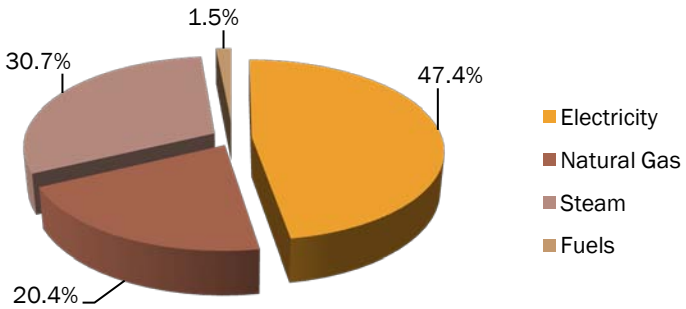


Figure 5-1 FY08 Energy Consumption at RSA

5.1.1 Action Plans

The visioning workshop was held as part of this master planning effort and highlighted a number of opportunities and challenges concerning energy at RSA, which are presented in Section 2.2.1. The resulting vision statement, which is to be a guide for this master plan, is to meet mandates through awareness and accountability, measurement, efficiency, control, and improvements in supply and distribution to eliminate fossil energy use and move toward a self-sustaining future. The following list of actions will build upon existing plans, overcome challenges, make progress against mandates, and achieve the vision.

5.1.1.1 *Energy Consumption Reduction*

Federal Targets
➢ *EPAct 2005 - Sec 102:* Provide 20% energy reduction by 2015 (superseded by EISA 2007)
➢ *EO 13243 - Sec 2(a):* Reduce energy consumption intensity 3% per year for FY08-FY15, 30% reduction by 2015 against 2003 baseline
➢ *EISA 2007 - Sec 431:* 3% per year for FY08-FY15, 30% reduction by 2015 against 2003 baseline
CEWMP Goals
➢ *Culture Change*
➢ *Eliminate Waste and Inefficiencies*
➢ *Improve Business Management Process and Practices*

Institute Accountability of Energy Consumption

Wasteful energy users will continue to over-utilize resources unless they are held personally accountable for their consumption. It is vital to hold all organizations (military, civilian, contractors, etc.) responsible for energy conservation. The following Action Plans provide measures to take to institute accountability:

- Maintenance contracts with incentives
  - Develop alternative maintenance contracts with incentives to maximize efficiency and minimize equipment running hours
  - Consider automated diagnostics for proactive operation and maintenance of large energy users
- Accountability for tenants and contractors on the installation
  - The energy management office at RSA currently has little authority to influence the consumption patterns in customer facilities although they are responsible for cost
  - Institute financial mechanisms to provide for cost recovery from tenants in the event of poor energy performance
- Accountability for facility operators
  - Develop and implement performance and reporting requirements for facility operators

Ensure Maximum Use and Benefit of Existing Facility Control Systems

Facility control systems can provide valuable energy savings by regulating facility temperatures based on a programmed operator input. It is highly important that these systems remain in healthy conditions in order to

continue providing reductions in energy consumption. The following recommended tasks will ensure RSA maintains maximum efficiency of all facility control systems:

- Review capabilities, status, and use of all control systems on installation
- Effectiveness of control systems
  - Identification of poorly performing facility control systems and causes
  - Regular training and/or reporting requirements for facility operators
  - Establishment and maintenance of building control schedules with changes in occupancy and function

Engage RSA Personnel in Energy Conservation through Promotional Awareness Programs

It is widely agreed that promotion of a culture of sustainability is a valuable and often underutilized strategy for reducing energy consumption. Increased engagement of, and cooperation from, Garrison personnel in pursuit of energy initiatives can produce measurable results at relatively low costs. RSA currently has an awareness program that includes post newspaper articles, newsletters, posters, new staff orientations, and other events and initiatives. Facilities also have building energy monitors that are trained through seminars that are organized by the energy manager.

The following are three primary challenges identified in the visioning workshop and interviews:

- The need to enhance current awareness programs
- The need to incorporate accountability for energy use, particularly among tenants on RSA
- The need for staff and funding resources to fully execute awareness programs

While energy managers are familiar with the capabilities and offerings of energy services providers, they are less so with branding, marketing, and management. Action plans to increase awareness and accountability should include recommendations from experts in those markets. Awareness programs for industrial safety that were developed in past decades were very successful and can be used as a benchmark for enhanced energy programs. A new awareness and accountability program may incorporate:

- One or more inspirational themes, or slogans, that tie energy to the mission of the Army or to RSA specifically
- Creation of promotional materials around the central themes that include post billboards, building placards, promotional videos for distribution and inclusion in events
- Implementation of electronic signs at post gates that display month-to-month resource consumption, progress against goals, recent achievements, and/or encouragement to staff, contractors and visitors to assist in sustainability initiatives
- Tasking building energy monitors to establish a baseline for daily, weekly, or monthly energy consumption, and record and track energy consumption against the baseline to identify and communicate problems and opportunities
- Formulation of appropriate mechanisms to incentivize energy reductions (contests, prizes, time-off awards) and penalize for poor performance (performance reviews, financial penalties for tenants)

Reduce Fossil Energy Consumption

RSA currently has the advantage of having a large portion of steam, representing 30.7% of FY08 energy consumption, supplied from waste-to-energy technology. To maximize use of this existing renewable source, RSA should:

- Reevaluate the steam options analysis conducted by Pacific Northwest National Laboratory (PNNL) giving priority to strategies that maximize the use of waste for energy while meeting energy reduction and other mandates
- Evaluate the use of biodiesel as a replacement for fuel oil in government-owned boiler plants

5.1.1.2 *Facility Metering*

Federal Targets
➢ *EPAct 2005 - Sec 103:* Sub meter all buildings by October 2012
➢ *EISA 2007 - Sec 434:* Meter all natural gas & steam building supplies by Oct 2016
CEWMP Goals
➢ *Comprehensive Data Management and Measurement*

Institute Energy Measurement Capability with Centralized Monitoring and Analysis

RSA is making progress in metering and measurement, including installation of smart meters in several facilities. Current plans also include the adoption of software that is supplied with the meters to enhance central monitoring capabilities. There is a clear need at RSA to enhance measurement, monitoring, and analysis of energy data. The current process of reviewing utility bills and collecting meter data for input to spreadsheets is tedious, time consuming, and limits the ability to prioritize activities and provide for continuous improvement.

A complete central monitoring system will have a resource portfolio management database that includes:

- Utility service and rate information
- Consumption data by facility and fuel source
- Baselines against which to compare energy data and identify problems
- Information and data related to goals and objectives that will allow for monitoring of progress toward monthly and annual targets
- Analysis routines and automated reporting functions to make all of the above convenient and effective

It is further possible to develop algorithms for required data reporting, as well as transfer of data to AEWRS and other required data repositories. Data can be uploaded to the database through smart meters that are in place or by building energy coordinators through a web portal. The database can also relate the Real Property Inventory (RPI) data with energy consumption and provide graphical views. There are comprehensive web-based and other database tools that are available to accomplish this objective. RSA is currently in the process of evaluating three different options for its energy accounting software.

5.1.1.3 *Renewable Energy Supply*

Federal Targets
➢ *EPAct 2005 - Sec 203:* Renewable energy supplied for 3% in FY07, 5% in FY10, up to 7.5% in FY13 of all electricity consumed, where economically feasible & technically practicable
➢ *EO 13243 - Sec 2(b):* At least 50% of current renewable energy purchases must come from new renewable sources (in service after January 1, 1999)
CEWMP Goals
➢ *Enhance Security*

Increase Renewable Energy Supply

Renewable technologies such as solar, biomass, and geothermal fuel sources are being studied in coordination with the Department of Energy (DOE). The following actions will help maximize progress:

- Investigate the use of renewable fuels in central energy plants and equipment that currently use conventional fuels
- Review current renewable resource studies for the Southeast region and document opportunities in biomass energy and alternative fuels technology from biomass
- Institute staff training to determine requirements for building integrated renewable energy technologies for potential inclusion in Request for Proposals (RFPs) for new facilities, as well as in major retrofits of existing facilities

As a final option, RSA can purchase 12 MWh of green energy from TVA's "Green Power Switch", which would amount to approximately 5% of total energy consumed. Although it will cost more than conventional power, it will allow RSA to meet Federal renewable energy targets in the short-term

Procure Renewable Energy from New Source (established after Jan 1, 1999)

Although the existing waste-to-energy plant does not meet criteria for a new renewable energy source, recent Government initiatives and declining renewable technology prices have made power from new renewable plants more available. It should be confirmed through future contracting processes that at least 50% of renewable power procured by RSA is generated from a new source.

5.1.1.4 *Federal Building Performance Standards*

Federal Targets
➢ *EPAct 2005 - Sec 109:* New Buildings to be 30% below ASHRAE 90.1 2004 baseline if life-cycle cost-effective
➢ *EISA 2007 - Sec 432:* Complete facility audits every 4 years for 25% of facilities. Implement life-cycle cost effective measures within 2 years
➢ *EISA 2007 - Sec 433:* For new/renovated buildings, reduce fossil fuel use by 55% in 2010, 100% by 2030 relative to a 2003 baseline
➢ *EISA 2007 - Sec 434:* Major replacements use most energy efficient design/equipment where life-cycle cost efficient
➢ *EISA 2007 - Sec 523:* 30% hot water to be met by solar systems by 2015 where life-cycle cost efficient
CEWMP Goals
➢ *Eliminate Waste and Inefficiencies*

Decrease Facility Energy Consumption

There is significant opportunity for RSA to decrease its energy consumption intensity through efficient new construction and retrofits of older facilities. Recently, new facilities have been commissioned with energy intensities closer to the 2003 baseline than the 2015 target, despite best efforts of the energy manager, master planners, and Army Corps of Engineers to document requirements in Requests for Proposals (RFPs) for new facilities. To remedy this problem RSA should incorporate the following:

- Integrated design approach from programming through construction management to ensure requirements for energy and water efficiency are addressed, funded, and properly implemented
- Compliance with the direction provided in the *High Performance and Sustainable Buildings Guidance (1 December 2008)* produced by the Federal Energy Management Program
- Automatic re-commissioning of new facilities six months after completion to ensure compliance with mandates
- Life-cycle cost calculations of solar hot water systems in any construction or retrofit designs

5.1.2 Future Focus

Elimination of fossil energy use, minimization of energy consumption, and progress toward a self-sufficient future are longer-term elements of the RSA vision for energy. This is a major challenge, primarily because it is difficult for alternative technologies to compete economically with well developed conventional technologies and infrastructure that use energy-dense and relatively inexpensive fossil sources. In order to completely replace fossil energy consumption and render Redstone Arsenal self-sufficient by 2030, planning to consider emerging utility-scale technologies should begin now in light of a changing political and technological landscape. The following sections discuss areas for Future Focus consistent with these long-term objectives:

5.1.2.1 *Update CEWMP Periodically*

Federal Targets
➢ *All Targets*
CEWMP Goals
➢ *All Goals*

There will be varying degrees of success resulting from the preceding Action Plan items, depending on system conditions. Once the above items are implemented, this CEWMP should be updated to review impacts to consumption patterns and revise Action Plans in order to take advantage of the new findings.

5.1.2.2 *Procure On-Site, Non-Fossil Energy*

Federal Targets
➢ *EPAct 2005 - Sec 203:* Renewable energy supplied for 3% in FY07, 5% in FY10, up to 7.5% in FY13 of all electricity consumed, where economically feasible & technically practicable
➢ *EO 13243 - Sec 2(b):* At least 50% of current renewable energy purchases must come from new renewable sources (in service after January 1, 1999)
CEWMP Goals
➢ *Enhance Security*

Renewable Energy Alternatives

- Hire energy technology and policy consultants to provide expertise and guidance navigating energy-policy scenarios working with private entities to secure captive, non-fossil heat and/or power for the Garrison.
- The 2-MW solar array at Fort Carson provides a benchmark for study. That procurement was achieved through a power-purchase agreement with private entities that specified long-term contractual terms, including power rates, and ensured captive power for the post.
- Consider revising contract with Tennessee Valley Authority (TVA) to provide a percentage of electrical power derived from renewable sources to meet federal mandates (i.e. 5% renewable energy sources in FY10).
- Large scale biomass or utility-scale nuclear energy technologies are possible at RSA, provided there is interest in the private sector and other required resources are available.
- Energy requirements on RSA may also be met by widespread implementation of alternative, distributed supply technologies on the post. Fuel cell technology is maturing and may be viable for implementation in the next 5-10 years. The installation can also consider biomass and/or renewable fuels for boilers and generators.
- Investigate Hyperion modular nuclear power. This technology is anticipated to be commercially ready in the next few years and may present an opportunity for RSA; however, it could not be used to meet renewable energy mandates.

Waste-to-Energy Steam Conversion

RSA has the opportunity to develop a reliable electrical source by converting steam energy generated at the central steam plant to electrical power for distribution throughout the installation. The development of an additional natural gas-fired steam plant could offset the loss of steam production. This transition would accomplish the following:

- Meet the EPAct 2005 future goal of 7.5% of electrical energy from renewable sources.
- Decrease steam energy efficiency losses from the aging distribution system.
- Decrease possible carbon emissions from TVA power plants by converting to natural gas supply.
- Enhance energy self-sufficiency by centralizing steam generation on post.
- Decrease RSA's reliance on the local utility for electrical power.

Discussions should be initiated with TVA on their current and long term plans for capacity expansion and options for non-fossil energy supply at RSA.

5.2 Water

The requirement for water use reduction at Federal agencies is addressed in EO 13423, as shown below:

Table 5-2 RSA Compliance with Federal Water Mandates

Requirement	Baseline	Target	FY08 usage intensity	% Change	Change Required to Meet Target
Reduction of water consumption intensity (GAL/SF) by 2% annually through 2015 or by 16% through 2015 **E0 13423**	84 (FY07)	78 (FY10) 70 (FY15)	65	-22% (FY07-08)	Target met (FY10) Target met (FY15)

*GAL/ft^2 = Gallons per Square Foot

As seen above, Redstone Arsenal has already met the FY15 water usage reduction goal of 16% from the FY07 baseline. The Action Plans and Future Focus strategies proposed below will continue the trends of water reduction and self sustainment.

5.2.1 Action Plans

The RSA CEWMP Vision Statement emphasizes security, reliability and sustainability. The Action Plans in this section provide a prioritized approach for achieving that vision as directly and efficiently as possible. Due to the nature of the RSA water system, the initial Action Plan item sets the tone for all subsequent action.

5.2.1.1 *Reestablish On-Site River Water as Primary Water Supply*

CEWMP Goals
- *Enhance Security*
- *Eliminate Waste and Inefficiencies*

Redstone Arsenal faces a single decision point that will guide all major aspects of the water system master plan from this point forward. That decision is which supply will be the long term primary water source: the on-site river supply or the off-site supply from the City of Huntsville.

The recommendation of this Master Plan is to utilize the on-site river supplies as the primary source for the potable water system, while maintaining the connections to Huntsville as a backup supply only. This recommendation is supported by the following conditions:

- Many of the RSA Water Strengths and Opportunities relate to the on-site supplies (abundance, reliability, security, established infrastructure, tenant compatibility)
- Many of the RSA Water Threats pertain to the off-site supply (security, cost control)
- With the off-site supply, much of the short-term water system capital improvement needs are directed toward making the RSA system compatible with the off-site supply (hydraulic limitations, fire flows, water quality disruptions, on-site storage)
- The water system design is already compatible with the on-site supplies, allowing for short-term capital improvements that will directly benefit conservation and business management programs (metering, leak detection, main replacement)
- The extensively used industrial water system requires an ongoing investment in plant operating resources—the use of these same resources for the on-site potable water supply increases efficiency and economy of scale for the combined systems
- Even with the off-site connections, for water security, reliability and public safety, the RSA on-site supplies need to be maintained in a ready state for nearly instantaneous use—this represents a substantial physical plant and operating overhead that is not efficiently utilized when designated for backup purposes only
- By establishing the Huntsville water supply as a secondary source, RSA may be able to avoid the indirect capital costs from the planned 36” main installation by keeping the existing infrastructure

- It is considerably less expensive (largely negligible) to maintain the Huntsville water main connections in a functional and reliable back-up water source status
- On-site water production capability presents long-term opportunities for bulk water sales to off-site systems

5.2.1.2 *Facility Metering*

CEWMP Goals
- *Provide Comprehensive Data Management and Measurement*

Establish System Wide Metering of Consumption Points

Implementing this Action Plan item involves an initial engineering plan and some capital expense; however, it is the foundation for many water system management activities that directly translate to the CEWMP goals of reliability, conservation, and user accountability. The following provides metering tasks:

- Conduct an engineering study to include a system metering plan, product alternatives and data management alternatives
- Equipment and software procurement, installation and construction contracts
- To perform proper consumption analysis it is imperative that the system operation contract includes meter reading and service
- A meter replacement program needs to be developed to ensure that meters continue to function properly

5.2.1.3 *Water Consumption Reduction*

Federal Targets
- *EO 13243 - Sec 2(b):* Reduce water consumption intensity 2% annually against 2007 baseline. 16% reduction by 2016.

CEWMP Goals
- *Culture Change*
- *Eliminate Waste and Inefficiencies*
- *Improve Business Management Process and Practices*
- *Enhance Security*

Institute Awareness and Accountability of Water Consumption

As with energy, the overall objective of water awareness is to "train" the workforce and tenants to conserve water on an individual basis without thinking about it. The currently available options generally rely on education and voluntary compliance, which are minimally funded and have limited success. The long-range goal is to institute programs to obtain buy-in via incentive programs, funded marketing plans and user accountability. Most instrumental will be implementation of tenant billing mechanisms to achieve water conservation the same way that metered billing promotes conservation with private and municipal water systems. The following initiatives can be established in conjunction with the energy awareness programs:

- Perform a marketing study to develop a water conservation marketing plan
- Implement the marketing plan and maintain it
- Institute DoD policy changes to enable tenant billing
- Establish a tenant billing program

Maximize Use of Industrial Water for Non-Potable Applications

The industrial water system is a unique alternative water source at Redstone Arsenal that has significant impact in and potential for replacing potable water consumption and reducing the cost of water production and energy resources used for treatment. The industrial water system has numerous advantages over other water supplies; it is plentiful, has an established infrastructure, is pressurized, and of high quality. The RSA DPW has been promoting the use of industrial water for non-potable applications, such as cooling water and lawn irrigation, when new development or major renovations occur in proximity to the industrial water system. However, budget limitations have historically limited the extension of the industrial water system to other locations. In order to accomplish this task, the following must be accomplished:

- Conduct a planning study to shortlist significant consumers of potable water for industrial purposes
- Conduct an engineering study to determine feasibility of substituting industrial supply for each shortlisted consumer, along with project requirements for main extensions and connections
- Implement contracts to meet the needs of the shortlisted consumers

Although converting potable usage to industrial consumption will not reduce overall water consumption, it replaces AEWRS-tracked potable water with a less costly alternative water source. The utility water supply requires less chemical additives than potable water, so it uses fewer natural resources for production and reduces environmental impacts when it is ultimately discharged.

This Action Plan item emphasizes the promotion of industrial water usage among more tenants and includes the programming of industrial water main extensions to areas with identified replacement usage potential, such as golf course irrigation and wash racks. Implementing this Action Plan item involves capital expense to facilitate the water main extensions.

Expand Water Main Leak Detection, Repair and Replacement Program

The RSA DPW has already initiated a leak detection program by purchasing leak detection equipment for the operating staff. In order for the program to have a significant impact on achieving the CEWMP goals, the operation should:

- Conduct annual leak detection surveys
- Generate main leak repair work orders
- Conduct immediate repairs of detected leaks
- Generate a repair catalog that assesses line damage, pH results, etc
- Develop a preventative maintenance program to continually identify depreciated water mains and determine where distribution main replacement should be considered
- Perform hydrant and valve exercises and replacements

Implementing this Action Plan item involves an increase in recurring water system operating and repair expenses. Reduced water production quantities will offset the implementation cost.

Perform Audits of High Water Using Processes

Audits of High Water Using Processes have been implemented by the DPW as described in the Planning Tools and Audits segment in Section 3.2.1.4. The same section provides a recommended list of user categories that warrant additional investigation. Historically, the DPW investigations have been hindered by the lack of end user metering data and the lack of investigatory staff resources. To combat this and develop a more comprehensive water reduction plan, the following actions are recommended:

- Utilize a planning study to profile high water using processes (e.g. wash racks)
- Conduct an engineering study to reduce water consumption in high usage areas
- Process upgrade equipment procurement and construction contracts to implement engineering study results

5.2.2 Future Focus

The water system Future Focus objectives provide a long range strategic plan for water system investments needed to achieve the installation water vision of security, reliability and sustainability. These plans will ensure that the RSA water infrastructure remains intact for many years to come.

5.2.2.1 *Update CEWMP Periodically*

Federal Targets
- *All Targets*

CEWMP Goals
- *All Goals*

There will be varying degrees of success resulting from the preceding Action Plan items, depending on system conditions. Once the above items are implemented, this CEWMP should be updated to review impacts to consumption patterns and revise Action Plans in order to take advantage of the new findings.

5.2.2.2 *Implement Comprehensive Data Management and Optimizing Tool*

CEWMP Goals
- *Provide Comprehensive Data Management and Measurement*

The development of a comprehensive water system data management program will be a gradual process at RSA. Ultimately, the program will integrate the key operational aspects of the water system under the umbrella of a single optimizing tool, or a collection of tools.

Such a tool would incorporate the following:

- Water flow, pressure, tank level and quality input (from the SCADA system and the hydraulic model)
- System-wide end user meter data
- Geospatial data
- Work order information including leaks, repairs, meter replacement, and valve and hydrant exercise activities
- Alert operating staff of suspected leak conditions
- Enable system managers to investigate high usage and inefficiency areas
- Optimize water maintenance and replacement activities
- Provide accurate and calibrated design modeling
- Program load management for pumping facilities
- Automated tenant billing

5.2.2.3 *Integrate Business Model*

CEWMP Goals
- *Improve Business Management Process and Practices*

In many ways, implementing a business model into the operation and management of the Redstone Arsenal water system encompasses the federal goals and RSA vision for efficiency and waste reduction. This business model would involve:

- Strategic system planning and management decisions
- Integrating efficiency awareness into design and equipment procurement processes
- Increasing preventative maintenance
- Performing routine operating and maintenance activities and purchases using streamlined work order and approval processes
- Institute mandatory energy efficient equipment procurement standards for all users
- Implement maintenance, repair and conservation activities warranted by standardized economic return analysis
- Plan and develop off-site water sales capability, if feasible
- Formally evaluate business model compliance and strategize new five year plan

As with the other Future Focus areas, integrating a business model into DoD operations will require fundamental changes to the established bureaucracy that can only occur over the long-term.

Section 6

Project Prioritization List

6 Project Prioritization List

The following PPLs are intended for use as working documents. They provide a "roadmap" for RSA to make necessary improvements and meet Federal mandates. The main tasks are prioritized by importance and subtasks provide specific actions to accomplish the larger goal. The time-frame recommendation for subtasks is designed to indicate actions that will have the greatest impact to energy and water efficiency:

- Immediate – 0-3 years
- Short-Range – 3-7 years
- Medium-Range – 7-15 years
- Long-Range – 15-25 years
- On-going – Can start immediately and run indefinitely

These subtasks can be implemented independent of the larger goal necessitating periodic updates of this working document.

6.1 Energy

Energy Prioritization List

ONE	**Increase Staffing for Energy Management:**
	Increase staff to implement this master plan and achieve short- and long-range Federal mandates (immediate)

TWO	**Institute accountability of energy consumption:**
	Develop alternative maintenance contracts that give conservation incentives, possibly utilizing an Energy Savings Performance Contract (immediate)
	Incorporate conservation ideas into the procurement and RFP processes for new facilities, integrating accountability for contractors (immediate)
	Develop a "wasteful users" penalization program for tenants and contractors (immediate)
	Implement automatic re-commissioning of facilities if an integrated design approach does not result in new facilities that obtain anticipated energy consumption efficiency goals (short-range)
	Develop and implement performance and reporting requirements for facility operators (short-range)

THREE	**Ensure maximum use and benefit of existing facility control systems:**
	Review the capabilities, status, and use of all building control systems on the post, including those that are not currently included in existing audit plans (immediate)
	Implement measures to maximize benefits, including training of staff, repairs, programming and scheduling, etc. (short-range)

FOUR	**Engage RSA personnel in energy conservation through promotional awareness programs:**
	Develop a conservation education program to be accompanied by an installation-wide incentive program (immediate)

Energy Prioritization List (cont.)

FIVE	**Institute post-wide energy measurement capability with centralized monitoring and analysis:**
	Select an installation resource portfolio management tool (short-range)
	Identify and document data requirements and institute procedures for input, both automated and manual. Manual input should be provided by facility operators (short-range)
	Identify the needs and protocols for interface between the portfolio management database and other essential databases (e.g. AEWRS) (short-range)
	Develop analysis routines needed for tracking and trending to generate automated reports (medium-range)

SIX	**Reduce fossil energy consumption:**
	Evaluate the use of bio-diesel as a replacement for fuel oil in government-owned boiler plants (short-range)

SEVEN	**Increase renewable energy supply:**
	Investigate the use of renewable fuels in central energy plants and equipment that currently use conventional fuels (immediate)
	Consider TVA's "Green Switch" program to purchase renewable energy as an immediate option to meet Federal mandates (immediate)
	Review DOE renewable energy studies and assess possibilities for biomass energy generation (short-range)
	Institute training of staff in determination of requirements for building integrated renewable energy technologies for inclusion in RFPs for new facilities and major renovations of existing facilities (short-range)

EIGHT	**Update CEWMP periodically:**
	Planning studies for periodic CEWMP updates (five-year cycles)

NINE	**Procure on-site, non-fossil energy:**
	Engage technology and policy consultants for guidance in navigating the energy policy landscape and in working with private entities to secure alternative sources (short-range)
	Investigate viable options for solar power (short-range)
	Initiate discussions with TVA on potential long-range strategies that will provide for alternative, captive energy supply, while meeting needs for capacity expansion (short-range)
	Review options for utility-scale energy, including nuclear technology (Hyperion) and large-scale biomass technologies (medium-range)
	Investigate options for widespread alternative, distributed energy generation using emerging technologies, including fuel cells and use of biomass/renewable fuels for boilers and generators (medium-range)

TEN	**Enhance energy security and self sufficiency:**
	Re-visit the use of the Huntsville (SWDA) waste-to-energy for the generation of electric power, whether directly at the plant or through steam turbines (short-range)
	Investigate production-capacity expansion plans of TVA and explore new renewable power supply (medium-range)
	Investigate the Hyperion modular nuclear power technology (long-range)

6.2 Water

Water Prioritization List

ONE	**Reestablish on-site river water as primary water supply:**
	Convert water system operations into full-time on-site water production (immediate)
	Water supply agreement with City of Huntsville for standby use only, whereby RSA provides in-kind service to the city (immediate)

TWO	**Establish system-wide metering of consumption points:**
	Conduct an engineering study to include a system metering plan, product alternatives and data management alternatives (immediate)
	Equipment and software procurement, installation and construction contracts (short-range)
	Negotiate water system operations contract supplement to include meter reading and service (short-range)
	Develop a meter replacement program (long-range)

THREE	**Institute awareness and accountability of water consumption:**
	Marketing study to develop water conservation marketing plan (immediate)
	Implement a funded and ongoing water conservation marketing plan (short-range)
	Institute DoD policy changes to enable tenant billing (medium-range)
	Institute tenant billing program (long-range)

FOUR	**Maximize use of industrial water for non-potable applications:**
	Planning study to shortlist significant consumers of potable water for non-potable purposes (immediate)
	Engineering study to determine feasibility of substituting industrial supply for each shortlisted consumer, along with project requirements for industrial water main extensions and connections (short-range)
	Industrial water main extension and connection construction contracts (medium-range)

FIVE	**Expand water main leak detection, repair and replacement program:**
	Annual leak detection surveys (immediate)
	Annual water main leak repair work orders (immediate)
	Water main repair catalog, including damage assessment field report, pipe wall samples and bedding soil pH test results, for all water main repairs (immediate)
	Planning study to develop a water main replacement master plan based on evaluation of water main repair frequency, water main repair catalog data, and water main specifications (medium-range)
	Water main replacement construction contracts (medium-range)
	Hydrant exercise and replacement program (implement short-range, program over long-range)
	Valve exercise and replacement program (implement short-range, program over long-range)

Water Prioritization List (cont.)

SIX	**Perform audits of high water using processes:**
	Planning study to profile, investigate, confirm and shortlist high water using processes. See Section 3.2.1.4 for a recommended list of user categories that warrant additional investigation at RSA (immediate or medium-range following installation of system-wide meters)
	Engineering study to determine feasibility, options and implementation costs for replacing or reducing water consumption with the shortlisted high water using processes (short-range)
	Process upgrade equipment procurement and construction contracts (medium-range)

SEVEN	**Update CEWMP periodically:**
	Planning studies for periodic CEWMP Updates (five-year cycles)

EIGHT	**Implement comprehensive data management and optimizing tool:**
	Upgrade SCADA (immediate)
	Upgrade hydraulic model (immediate)
	Update water system geospatial database (immediate)
	Institute system-wide metering (short-range)
	Develop integrated work order database (short-range)
	Integrate centralized distribution system hydraulic design model review program for all proposed water system main extensions, main enlargements, tanks and booster station (medium-range)
	Develop leak and high water usage alert system (medium-range)
	Develop optimized preventative maintenance scheduling application (medium-range)
	Develop real-time optimized booster station load management system (medium-range)
	Develop real-time meter data acquisition and billing system (long-range)

NINE	**Integrate business model:**
	Institute mandatory energy efficient equipment procurement standards for all users (on-going)
	Implement maintenance, repair and conservation activities warranted by standardized economic return analysis (medium-range)
	Plan and develop off-site water sales capability, if feasible (medium- range)
	Institute DoD policy changes to enable streamlined work order and approval process (on-going)


SUSTAIN
SUPPORT
DEFEND


REXROAD
A P G